CITY OF SEQUIM

CLALLAM COUNTY **WASHINGTON**

DRAFT
WEST FIR STREET IMPROVEMENTS
STORMWATER SITE PLAN

G&O #14538.01
APRIL 2016

Gray & Osborne, Inc.
CONSULTING ENGINEERS

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

PROJECT ENGINEER’S CERTIFICATION

“"I hereby certify that this Drainage and Erosion Control Plan for the Sequim W Fir Street Project has been prepared by me or under my supervision and meets minimum standards of the City of Sequim and normal standards of engineering practice. I hereby acknowledge and agree that the jurisdiction does not and will not assume liability for the sufficiency, suitability, or performance of drainage facilities designed by me."

NANCY LOCKETT, P.E.

SECTION A – PROJECT OVERVIEW

The intent of this project is to bring West Fir Street into compliance with the City's School Connection Roadway Standards, underground existing overhead utilities, and to replace existing utilities in the project area to accommodate future service demands.

West Fir Street provides direct access to Helen Haller Elementary School and Sequim Senior High School. As such, the road needs to be brought into compliance with the School Connection Roadway Standards, as noted in the City of Sequim's 2013 Transportation Master Plan. The pavement along West Fir Street has shown signs of fatigue and failure in multiple areas.

Schedule A of this project includes a full reconstruction and realignment of approximately 0.49 miles of West Fir Street from North 5th Avenue to North Sequim Avenue. The reconstructed roadway typical cross-section will accommodate two 11-foot travel lanes, 5-foot bike lanes on both sides of the road, limited on-street parking, cement concrete curbs, gutters and sidewalks, and a 4-foot landscaping strip along a portion of the north side of the project site. This schedule of work also includes installation of a traffic signal at the intersection of North 5th Avenue and West Fir Street; new storm improvements, irrigation system improvements, illumination, signing, undergrounding of existing overhead utilities, and landscaping. Right-of-way will be purchased as part of this work.

Schedule B of this project includes the rehabilitation of the existing water and sewer utilities in West Fir Street from North 5th Avenue to North Sequim Avenue in conjunction with the rehabilitation of West Fir Street. More specifically, the utility improvements will include:

- Replacing an existing 8-inch AC waterline from North 4th Avenue to North Sequim Avenue and an existing 2-inch water line with North 5th Avenue to North 4th Avenue with approximately 2,800 linear feet of 10-inch water main.

- Replacing an existing 8-inch sewer line between North 3rd Avenue and North Sequim Avenue with a 12-inch-diameter sewer pipe. Install new 12-inch-diameter sewer pipe from North 5th Avenue to North 3rd Avenue. The total length of new and replaced sewer is approximately 2,800 linear feet of 12-inch sewer pipe.

This site was identified in the 2015 Draft Stormwater Comprehensive Plan as a high priority stormwater problem (item number 2.64). During large storms, water from West Fir Street tends to flow onto the adjacent school properties and pond against buildings, or flow across the entire school yard. This project will fix the existing drainage problems.

The stormwater BMPs used on the project site will be designed using the 2012 *Stormwater Management Manual for Western Washington* (Manual; Washington Department of Ecology, 2012).

The proposed stormwater management methods include full infiltration for flow control and a biofiltration cell for water quality.

Tables 1 and 2 include a summary of the land to be disturbed during construction of the project, as well as the amount of existing and future pervious and impervious surfaces. Per the Manual, the predeveloped area is assumed to be 100 percent forested conditions. The Site Plan may be seen on Figure 1.

TABLE 1

Land Disturbing Activity (Acres)

Existing Impervious Surface	3.95
New Impervious Surface	0.55(1)
Replaced Impervious Surface	3.59
Native Vegetation Converted to Lawn or Landscaping	0
Native Vegetation Converted to Pasture	0
Replanted Landscape	0.96
Total Amount of Land Disturbing Activity	5.11

(1) Includes existing gravel areas to be resurfaced with asphalt.

TABLE 2

Site Parameters

	Predeveloped Area	Post-Developed Area
Impervious Surface	0	4.15
Forested	5.11	0
Landscaped	0	0.96
Total	5.11	5.11

INCREASE IN 100-YEAR FLOOD FREQUENCY

The project plan includes 4.15 acres of new and replaced impervious area – consisting of the new and replaced pavement on the roadway and parking areas, as well as the new and replaced concrete sidewalks. The total pollution-generating impervious area onsite is 3.10 acres – this does not include the sidewalks.

WWHM2012 was used to determine the pre- and post-developed site flow rates tributary to the proposed infiltration facilities.

TABLE 3

WWHM2012 Site Parameters

	Predeveloped Area	Existing Area	Post-Developed Area
Impervious Surface	0	3.95	4.15
Forested	5.11	0	0
Landscaped	0	1.16	0.96
Total	5.11	5.11	5.11

TABLE 4

Project Site Flow Rates

Storm Event	Predeveloped Flow (cfs)	Existing Flow (cfs)	Proposed Flow (cfs)
2-Year	0.0029	1.1203	1.1729
10-Year	0.0045	1.8176	1.8980
25-Year	0.0051	2.1921	2.2867
50-Year	0.0054	2.4814	2.5867
100-Year	0.0056	2.7796	2.8957

The 100-year flow increase over the existing condition will be 0.1161 cfs. The increase over the predeveloped condition is 2.8901 cfs.

THRESHOLD DISCHARGE AREAS

The project site encompasses one threshold discharge area, including one natural discharge location, located at the east end of the project area. The entire project site is within the Gierin Creek Basin, which is located within the Elwha/Dungeness Watershed.

Runoff from the project area flows to the northeast, following the overall slope and topography of the City. The road will be graded to follow the existing contours, as the overall slope of the road from west to east is less than 1 percent. Runoff will be collected through catch basin inlets along both sides of the roadway, where it will flow to underground gravel trenches located beneath the sidewalks to be infiltrated. In the natural condition, flows from the project area would infiltrate and most likely not reach Gierin Creek, which is located within the City, approximately 2,000 feet down slope of the project site to the northeast. The Creek very rarely carries any flow within the City limits, and is mostly fed by irrigation in summer and localized stormwater runoff in winter. There is no existing manmade drainage conveyance that would carry stormwater runoff from the project site to Gierin Creek. Gierin Creek flows from the City limits approximately 2.25 miles to the northeast to discharge into the Strait of Juan de Fuca. Gierin Creek is not listed on Ecology's 303d water quality list for impaired water bodies, so no additional TMDL requirements apply.

The areas surrounding the project site are entirely developed or cleared. There are no streams, wetlands, or other water bodies in the vicinity of the project site.

APPLICABLE MINIMUM REQUIREMENTS

The project is a redevelopment road project that adds more than 5,000 square feet of new hard surface area. It is a road related project that does not add more than 50 percent to the existing hard surface area. Minimum Requirements 1 through 9 apply to the new hard surfaces and converted vegetation areas.

TABLE 5

Change in Land Cover

	Existing (ac)	Proposed (ac)	Change (ac)
Asphalt Pavement	2.99	3.10	0.11
Concrete	0.01	0.02	0.01
Gravel	0.35	0.01	-0.34
Concrete Sidewalk (and Curb/Block Wall)	0.59	1.02	0.43
Lawn/Dirt/Landscape	1.16	0.96	-0.20
Building Roof	0.01	0.00	-0.01
Total Project Area	5.11	5.11	0.00

TABLE 6

Summary of Manual Requirements

	Pollution-Generating Impervious Surface	Non-Pollution Generating Impervious Surface	Pervious Surface
New	0.12[(1)(2)]	0.43[(1)]	--
Replaced	3.00	0.59	--
Total	3.12	1.02	0.97

(1) Flow Control Applies (total 0.55 ac).
(2) Water Quality Applies (total 0.12 ac).

SECTION B – EXISTING CONDITIONS SUMMARY

SITE LOCATION

The project is located in Section 19 of Township 30 North, Range 3 West within the City of Sequim, in Clallam County, Washington. The project limits are in and along West Fir Street, between North 5th Avenue and North Sequim Avenue, and additional area outside of the street right-of-way.

Refer to the attached Vicinity Map for the project location (Figure 2).

SITE TOPOGRAPHY AND CRITICAL AREAS

The project site is very flat with minimal slopes. The site gradient along the roadway slopes downward at about 1 percent from west to east. Drainage on the site follows the site slopes, and the roadway will be graded to closely match the existing grade. The roadway will be crowned at the centerline to aid in runoff collection and management.

Vegetative groundcover on the site includes mostly grass and lawn, with some trees on the adjacent properties.

EXISTING ON-SITE STORMWATER SYSTEMS

The project site currently has no stormwater conveyance, stormwater flow control, or treatment facilities. Water sheet flows off of the site to the east, following the roadway grade. Runoff from the road frequently floods across adjacent properties to the north of the roadway.

SITE PARAMETERS

The site is located along a developed road in an urban area of the City, so there are many existing utilities located above and below ground along West Fir Street. The locations of these facilities, and the proposed utilities, may affect the location and sizing of stormwater facilities. There are no other abnormal site conditions that may affect the installation of stormwater management facilities.

SITE DRAINAGE

The shallow slopes on the project site direct drainage generally from southwest to northeast. The project site is entirely located within City right-of-way, encompassing an area of approximately 5.11 acres. On the north side of the roadway, there is a Boys and Girls Club, at the intersection of North 5th Avenue and West Fir Street, Helen Haller Elementary School at the intersection of North 4th Avenue and West Fir Street, and Sequim High School at the intersection of North Sequim Avenue and West Fir Street. A number of single-family homes exist along the south side of the street, along with a School District building, businesses, and a church. The topography of the City slopes downward from southwest to northeast, though the slopes are generally very shallow. It is not anticipated that any significant volumes of stormwater flow onto the project site from nearby properties, apart from small amounts of runoff from lawns directly adjacent to the roadway or sidewalks. The site is located within the Elwha/Dungeness watershed, WRIA #18.

SITE SUITABILITY FOR STORMWATER INFILTRATION

A geotechnical investigation was conducted as part of this analysis by PanGEO, Inc. in January 2016 (Appendix A). The geotechnical engineer determined that infiltration is feasible throughout the site due to the presence of well-draining, sandy soils along the length of the roadway. Infiltration tests were done at six locations along the project length in the roadway to determine feasibility of roadside bioretention and infiltration facilities. The tests were completed at depths from 2.5 to 11.5 feet below ground surface (bgs), to capture the range of depths of potential infiltration facilities. Throughout the site, design infiltration rates, including a correction factor of 0.18, as determined by the geotechnical engineer, ranged from 2.0 in/hr to 12.7 in/hr. At those locations determined to have an infiltration rate above 10 in/hr, the geotechnical engineer recommends using an infiltration rate of 10 in/hr for modeling.

TABLE 7

Site Infiltration Rates

Borehole	Infiltration Rate at Depth		
	2.5' to 4' bgs	5' to 6.5' bgs	10' to 11.5' bgs
2	5.7 in/hr	not measured	3.9 in/hr
3	not measured	3.9 in/hr	5.3 in/hr
4	8.8 in/hr	12.7 in/hr(1)	2 in/hr
5	4.7 in/hr	12.3 in/hr(1)	11.4 in/hr[1]

(1) The geotechnical engineer recommends a maximum infiltration rate of 10 in/hr for design purposes.

The bottom of the infiltration trenches are proposed to be approximately 4.5 to 5 feet below ground level, so the infiltration rates at 5 to 6.5 feet below ground level were used for the modeling in WWHM2012 (the shallower measurement was used at borehole 2 in lieu of a measurement at 5' bgs). The shaded boxes in Table 7 indicate the infiltration rates used in the design of stormwater facilities.

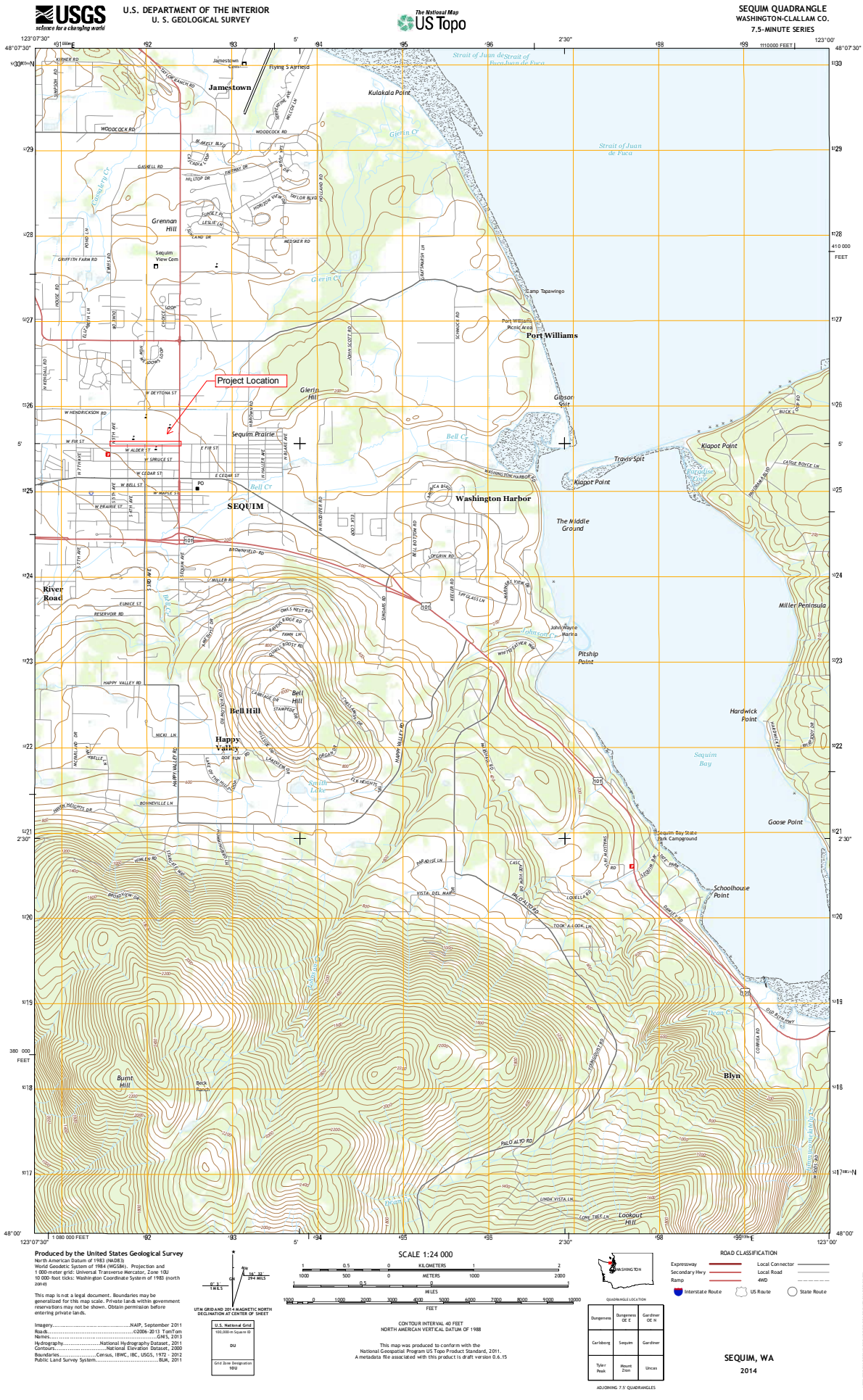
The infiltration rates were assumed to apply over different sections of the project:

TABLE 8

Site Division for Modeling

Station	Length	% of Project Length	Infiltration Rate
10+00 to 24+25	1,425'	51%	5.7 in/hr
24+25 to 27+25	300'	11%	3.9 in/hr
27+25 to 38+00	1,075'	38%	10 in/hr

FIGURE 2 - VICINITY MAP



A weighted average of the infiltration rates over the project lengths results in an average infiltration rate (rounded down) of approximately 7 in/hr for the entire site. The minimum rate on the site is 3.9 in/hr.

WATER TABLE ELEVATIONS AND FLOW DIRECTIONS

The geotechnical investigation found no evidence of groundwater within the test pits. An earlier geotechnical investigation at a nearby site, the Sequim Civic Center site, found evidence of groundwater at 36 to 39 feet below grade. The geotechnical engineer believes the groundwater level at the Sequim Civic Center site to be a fair representation of the conditions at the West Fir Street project area, so any installed infiltration facilities will have sufficient separation from groundwater.

SOIL PARAMETERS

According to the USDA Soil Survey, soils within the project area are entirely composed of Sequim very gravelly, sandy loam, Hydrologic Group A.

The geotechnical investigation confirmed the results of the Soil Survey. The investigation encountered 0.5 to 1 foot of possible fill across the project site, underlain by older alluvium ranging from poorly graded gravel with sand and silt content to poorly graded sand with silt and gravel content. These soils are well-suited for infiltration.

SECTION C – OFF-SITE ANALYSIS

Runoff from the site currently sheet flows, as there is no stormwater drainage infrastructure in the project area. The surrounding parcels are entirely developed or cleared. Slopes in the vicinity of the site are very shallow, so it is unlikely that any significant amount of runoff from the nearby properties flows onto the project site, other than from small areas of lawn directly adjacent to the sidewalks.

Currently, there are residential, commercial, and public properties along either side of the project site, and the nearest buildings are located directly adjacent to the existing right-of-way. No existing roads other than the project section of W Fir Street and the associated intersections with North 5th Avenue, North 4th Avenue, North 3rd Avenue, North 2nd Avenue, and North Sequim Avenue will be affected.

Flows from the constructed project site will be managed entirely through infiltration.

SECTION D – SUMMARY OF MINIMUM REQUIREMENTS

This Stormwater Site Plan serves to satisfy Minimum Requirement 1 (Preparation of Stormwater Site Plans).

A Stormwater Pollution Prevention Plan (SWPPP) has been prepared to satisfy Minimum Requirement 2 (Construction Stormwater Pollution Prevention). The SWPPP is included as Appendix C.

Source Control BMPs will be employed during construction as outlined in the SWPPP included in this Site Plan to satisfy Minimum Requirement 3 (Source Control of Pollution).

Natural drainage systems and outfalls at the project site will be maintained by the proposed stormwater management techniques to be used on site – infiltration – to satisfy Minimum Requirement 4 (Preservation of Natural Drainage Systems and Outfalls). Flows within the project area will be infiltrated. No outfall locations will be added or modified.

Stormwater will be managed entirely by on-site Stormwater Management BMPs including infiltration and StormFilter cartridges. This will satisfy Minimum Requirement 5 (On-Site Stormwater Management). Easements will be obtained if necessary for the stormwater system, and some amount of right-of-way will need to be purchased to accommodate the new road section.

Minimum Requirement 6 (Runoff Treatment) states that runoff treatment is required for those projects that:

> "[Include a] total of effective, pollution-generating impervious surface (PGIS) of 5,000 square feet or more in a threshold discharge area of the project, or
>
> [Include a] total of pollution-generating pervious surfaces (PGPS) of three-quarters (3/4) of an acre or more in a threshold discharge area, and from which there is a surface discharge in a natural or man-made conveyance system from the site."

The entire new and replaced surface within the roadway and parking area is pollution-generating, while the new and replaced sidewalks are considered non-pollution generating. This minimum requirement only applies to the new PGIS on site, which comprises approximately 0.12 acres of roadway. A bioretention cell will treat and infiltrate runoff from a minimum area of 0.12 acres of pollution-generating surface as well as approximately 0.1 acres of adjacent sidewalk and lawn. The bioretention cell may be located within any landscape area, such as the 4-foot wide planter strip along the north side of the site, or in the landscape area at the east end of the site. The bioretention cell was modeled in WWHM2012 and will provide the necessary water quality treatment volume required for the entire project to meet Minimum Requirement 6 (Runoff Treatment). Runoff tributary to the bioretention cell will infiltrate to the subsurface. An overflow will be provided to an adjacent infiltration trench, though the bioretention area should be more than adequate for the tributary flows, up to and exceeding the 100-year

storm event. The bioretention cell will be fed by catch basins and curb inlets to collect runoff from the north side of the roadway and from the adjacent sidewalk area.

Minimum Requirement 7 (Flow Control) states that if the flow during the 100-year storm will be increased by less than 0.1 cfs, then the project is exempt from flow control requirements. As shown in Table 4, the project will result in an increase in flow greater than 0.1 cfs during the 100-year storm and, therefore, is subject to flow control. This minimum requirement applies only to new hard surfaces within the project area, which comprises approximately 0.55 acres of roadway and sidewalk. The proposed stormwater facilities will provide flow control for the entire project site, as the existing site currently has no flow control infrastructure. Underground infiltration trenches and a bioretention facility have been sized to infiltrate runoff volumes up to the 100-year flow from the project's hard surfaces and any other tributary lawn or landscaped areas. The facilities have been sized to collect all runoff from the site.

Minimum Requirement 8 (Wetlands Protection) does not apply to the site, as runoff from the project site will not be directed to a wetland. There are no wetlands located on or nearby the project site.

An Operations and Maintenance Manual is included in this Site Plan as Appendix D to satisfy Minimum Requirement 9 (Operation and Maintenance).

SECTION E – PERMANENT STORMWATER CONTROL PLAN

Due to the addition of more than 2,000 square feet of new impervious surface, the Manual states that a Stormwater Site Plan is required and the project must comply with Minimum Requirements 1 through 9. However, as described in the Project Overview section, the project is exempt from Minimum Requirement 8. The following describes the design process behind the proposed stormwater control infrastructure, including infiltration and treatment.

PROPOSED SITE CONSTRUCTION AND STORMWATER MITIGATION METHODS

The City of Sequim proposes to bring West Fir Street into compliance with the City's School Connection Roadway Standards, underground existing overhead utilities, and replace existing utilities within the project area to accommodate future service demands. This would entail a full reconstruction and realignment of approximately 0.49 miles of West Fir Street from North 5th Avenue to North Sequim Avenue. The reconstructed roadway typical cross-section will accommodate two 11-foot-wide travel lanes, 5-foot wide bike lanes, limited on-street parking, cement concrete curbs, gutters, and sidewalks, and a 4-foot wide landscaping strip. The project would also include installing a traffic signal at the intersection of North 5th Avenue and West Fir Street, new storm improvements, irrigation system improvements, illumination, signing, undergrounding of existing overhead utilities, and landscaping. Right-of-way will also be purchased.

Existing water and sewer utilities will be rehabilitated in West Fir Street from North 5th Avenue to North Sequim Avenue. This will include:

- Replacing an existing 8-inch AC waterline from North 4th Avenue to North Sequim Avenue and an existing 2-inch waterline from North 5th Avenue to North 4th Avenue with approximately 2,800 linear feet of 10-inch water main; and

- Replacing an existing 8-inch sewer line between North 3rd Avenue and North Sequim Avenue with a 12-inch-diameter sewer pipe, and installing a new 12-inch-diameter sewer pipe from North 5th Avenue to North 3rd Avenue, with the total length of new and replaced sewer being approximately 2,850 linear feet of 12-inch pipe.

The typical depth of excavation for the roadway prism will be approximately 10 inches. Ground disturbance for utility construction will range from 2.5 to 13 feet below surface.

As described previously, gravel infiltration trenches will be used to provide runoff flow control for the entire site. Approximately 0.547 acres of the new hard surfaces on site requires flow control; however, runoff from the entire site will be managed through infiltration.

The infiltration trenches will each consist of a perforated 12-inch drain pipe laid within a 3-foot deep layer of gravel which will infiltrate to the native subgrade. The 12-inch perforated pipe will be laid on top of 1.5 feet of drain gravel and covered by an additional 0.5 feet of gravel. This will be installed below the 6-inch layer of CSTC and 4-inch cement concrete sidewalk. Curb inlets and catch basins will collect runoff from the roadway to route flows to the infiltration trenches below the sidewalks, providing flow control for the site. The catch basins and curb inlets will be spaced approximately every 150 feet along either side of the roadway; the infiltration trenches will also be installed on either side of the roadway and no storm pipes will cross the roadway. The trenches will be 5-feet wide in order to fit within the sidewalk width and to avoid conflicts with other utilities. Pairs of curb inlets will flow into each infiltration trench, and some trenches will collect greater volumes than others, depending on their location within the site. A resulting total of approximately 2,600 feet of infiltration trench will be installed throughout the project length – approximately 1,300 feet on either side of the roadway. See the Site Plan for details.

The Manual encourages the use of water quality facilities prior to infiltration facilities to help remove debris and solids before infiltration. The lower the influent suspended solids loading to the infiltration facility, the longer the infiltration facility can infiltrate the desired amount of water or more, and the longer interval between maintenance activities.

Given that the City performs street sweeping and catch basin/inlet cleaning on a regular basis, uses deicer rather than sand for deicing, the pretreatment provided prior to

infiltration facilities will consist of a curb inlet with downturned elbow. This level of pretreatment should be adequate for the site, as the City will conduct regular inspection and maintenance of the infiltration trenches. Additionally, the trenches will be oversized in order to provide additional capacity in the event of unusually large storms or if some the gravel section becomes clogged by sediment.

Sizing for the infiltration trenches was done using the WWHM2012 program. The following table includes the minimum lengths required for each section of the project site, split by infiltration rate.

TABLE 9

Infiltration Trench Requirements by Section

Station	Infiltration rate	Total Required length of Infiltration Trench (5-Feet-Wide by 3-Feet-Deep)
10+00 to 24+25	10 in/hr	370'
24+25 to 27+25	3.9 in/hr	150'
27+25 to 38+00	5.7 in/hr	400'

As mentioned, the actual length throughout the project site will be approximately 2,600 feet of infiltration pipe. This is approximately 3 times longer than the required length that the model reports of 920 feet.

The entire site, undivided, was also input as a check on the minimum necessary length of infiltration trench, given the site average infiltration rate of 7 in/hr, or the minimum infiltration rate of 3.9 in/hr, representing a worst case scenario. Table 10 shows that the worst case scenario – if the entire site infiltration rate was 3.9 in/hr (the measured minimum rate at 5 feet below ground level) – the minimum infiltration trench length required would be 1,330 feet. This is approximately half of the proposed length of infiltration trench to be provided – approximately 2,600 feet. The proposed infiltration trenches will have sufficient capacity to infiltrate all runoff from the site without incurring overflows.

TABLE 10

Infiltration Trench Requirements – Site Average and Minimum

Infiltration rate	Required length of Infiltration Trench (5-Feet-Wide by 3-Feet-Deep)
7 in/hr (approximate site average)	920'
3.9 in/hr (site minimum at infiltration trench bottom)	1,330'

Treatment will be provided by a biofiltration cell within a landscaped area on site.

The bioretention facility will collect flows from a minimum area of 0.12 acres of pollution-generated surface, as well as approximately 0.1 acres of adjacent sidewalk and lawn. If the landscaped area at the east end of the site is used for bioretention, the tributary area due to site topography will be approximately 0.262 acres (0.2 acres of which is pollution generating). As the required water quality area is 0.12 acres of pollution generating surface, this exceeds the requirement. Table 11 includes a summary of the potential bioretention facility sizing, depending on where the facility is located. The landscape area at the east end of the site was modeled with 3:1 H:V side slopes and an underlying infiltration rate of 5.4 in/hr. The planter strip bioretention option was modeled with 0 side slopes, as this facility would be installed in a concrete planter box, and an underlying infiltration rate of 3.7 in/hr.

TABLE 11

Bioretention Facility Sizing

Location	Tributary Area	100-Year Flow Rate	Water Quality Flow Rate	Bioretention Facility Surface Area
Landscape Area at East End of Site	0.262 ac	0.1474 cfs	0.0268 cfs	17' x 55'
4' Wide Planter Strip	0.170 ac	0.1197 cfs	0.0215 cfs	90' x 4'

SOURCE CONTROL BMPS

Dust control may be necessary during demolition and construction. The entire project site is currently developed and paved, so no clearing will take place. The removal and replacement of the existing paved and landscaped areas may produce small amounts of dust. Dust production will be minimized during construction as necessary through the following BMPs (as described in BMP C140 in Volume II of the Manual):

> *"Vegetate or mulch areas that will not receive vehicle traffic. In areas where planting, mulching, or paving is impractical, apply gravel or landscaping rock.*
>
> *"Limit dust generation by clearing only those areas where immediate activity will take place, leaving the remaining area(s) in the original condition. Maintain the original ground cover as long as practical.*
>
> *"Sprinkle the site with water until surface is wet. Repeat as needed. To prevent carryout of mud onto street, refer to Stabilized Construction Entrance (BMP C105).*

> *"Irrigation water can be used for dust control. Irrigation systems should be installed as a first step on sites where dust control is a concern."*

Long-term pollutant control will be managed by the proposed bioretention cell. This facility will trap debris and sediment tracked along the roadway by cars before runoff infiltrates to groundwater. The bioretention cell will provide adequate treatment in accordance with Volume V of the Manual to satisfy Minimum Requirement 6. The remainder of the site's runoff will be managed by underground infiltration trenches, which will be fed by curb inlets. The inlets will each contain a sump and a downturned elbow to limit debris and suspended solids on the roadway from entering the infiltration trenches.

LOCATION OF ON-SITE BMPS

The bioretention cell will be located roadside within a landscape area on site (the exact location is yet to be determined), in order to satisfy Minimum Requirement 6. The infiltration trenches will be located beneath the sidewalks, fed by catch basins and/or concrete inlets, as shown on the Site Plan, which will collect flows along the entire length of the roadway. The roadway will be graded so that runoff flows into the inlets along the curbs and not onto adjacent properties.

APPLICABLE GEOTECHNICAL STUDIES

Draft Geotechnical Report – West Fir Street Rehabilitation: North 5th Avenue to North Sequim Avenue, Sequim, WA; PanGEO, Inc., January 2016.

The PanGEO, Inc. geotechnical report was conducted to investigate site suitability for infiltration facilities and for pavement and sidewalk thickness. The report consists of site reconnaissance and excavation, observation, and analysis of six test pits.

DESIGN CRITERIA

Infiltration Trenches

Volume III, section 3.3.11 of the SWMMWW was used for the design of the infiltration trenches proposed for the site.

> *"Due to accessibility and maintenance limitations, carefully design and construct infiltration trenches. Contact the local jurisdiction for additional specifications."*

The City will review the proposed design prior to construction.

> *"Consider including an access port or open or grated top for accessibility to conduct inspections and maintenance."*

The infiltration trenches will each be approximately 325-feet long and will include an access/monitoring port for inspection purposes. In the event that serious maintenance is required, the sidewalk above the trench would need to be removed and replaced.

> *"Backfill Material - The aggregate material for the infiltration trench should consist of a clean aggregate with a maximum diameter of 3 inches and a minimum diameter of 1.5 inches. Void space for these aggregates should be in the range of 30 to 40 percent."*

The aggregate material will meet these requirements. The infiltration trenches were modeled in WWHM2012 assuming void space of 33 percent.

> *"Geotextile fabric liner – Completely encase the aggregate fill material in an engineering geotextile material. Geotextile should surround all of the aggregate fill material except for the top one-foot, which is placed over the geotextile. Carefully select geotextile fabric with acceptable properties to avoid plugging (see Appendix V-C of Volume V)."*

The infiltration trenches will be surrounded by geotextile, meeting the guidelines in Volume V.

> *"The bottom sand or geotextile fabric as shown in Figure 3.3.10 is optional."*

This optional addition will not be included.

> *"Overflow Channel - Because an infiltration trench is generally used for small drainage areas, an emergency spillway is not necessary. However, provide a non-erosive overflow channel leading to a stabilized watercourse."*

As there is no feasible stabilized water course to route overflows to in the vicinity of the project site, an overflow will not be provided. As explained earlier, the trenches are oversized by a factor of 3, so overflows are not anticipated. Runoff from the project site in its current condition sheet flows across the roadways and properties in the area and likely infiltrates in cleared areas, as the nearest watercourse is more than 0.5 miles to the northeast of the project site.

> *"Surface Cover - A stone filled trench can be placed under a porous or impervious surface cover to conserve space."*

The infiltration trenches will be placed beneath the sidewalks along either side of the street as available space on site for the installation of new utilities is limited.

> *"Observation Well - Install an observation well at the lower end of the infiltration trench to check water levels, drawdown time, sediment accumulation, and conduct water quality monitoring. Figure 3.3.10 illustrates observation well details. It should consist of a perforated PVC pipe which is 4 to 6 inches in diameter and it should be constructed flush with the ground elevation. For larger trenches a 12-36 inch diameter well can be installed to facilitate maintenance operations such as pumping out the sediment. Cap the top of the well to discourage vandalism and tampering."*

Four- to 6-inch-diameter perforated pipe will be installed in each infiltration trench for observation purposes.

The infiltration trenches were sized in WWHM2012 using a gravel depth of 3 feet with a porosity of 0.33, and a width of 5 feet. The trenches were not modeled to have any storage capacity beyond the gravel layer as the perforated pipes draining to the trench will be 12-inch and not designed for detention. The trenches were sized in total to determine a minimum length required for the various infiltration rates determined by the geotechnical report. The proposed installation will greatly exceed the minimum required lengths for 100 percent infiltration. See Appendix B for the modeling inputs and outputs.

Bioretention Facilities

The bioretention facility, which will provide water quality benefits, was designed according to BMPT7.30 in Volume V of the SWMMWW.

The proposed site does not trigger any of the listed infeasibility criteria – slopes on site are very gradual, the subsurface infiltration rate is moderate to high, and no hazard areas exist on site or nearby.

The default bioretention soil mix in WWHM2012 was used to determine minimum required bioretention area to treat the equivalent new PGIS area. The facilities were modeled to determine a total area required for the tributary area and were sized to infiltrate 100 percent of the tributary flow – no underdrain is proposed. A bioretention soil depth of 1.5 feet was used for modeling; the facility was sized to include 1 foot of freeboard over the surface of the engineered soil. See Appendix B for the modeling inputs and outputs.

ON-SITE APPLICATION OF LID MEASURES

A biofiltration cell will be used to provide water quality treatment and to infiltrate some flows. Infiltration trenches will be used to manage runoff from the rest of the site – the

infiltration trenches have been designed to be able to accommodate all runoff from the site, and have been oversized for the expected flows.

ANALYSIS ASSUMPTIONS

It is assumed that there are no unstable soils on site based on the geotechnical investigation. It is also assumed that given the flat topography and infiltrative soils in this area of Sequim off-site flows will not flow onto the roadway.

SITE SUITABILITY

The underlying soils are almost entirely Sequim very gravely sandy loam in the project area. Slopes surrounding the project site are generally flat – less than 5 percent. The project site itself will be regraded slightly to manage runoff.

CONVEYANCE SYSTEM

The total effective impervious area is greater than 10,000 square feet. An increase in the 100-year flow frequency of greater than 0.1 cfs will result from the new pervious area, so flow control is required. Flow control will be addressed through the infiltration facilities.

The total impervious area on site will be 4.15 acres, 3.123 of which is pollution-generating.

The impervious area on site is composed of asphalt roadway, bike lanes, and parking areas, as well as concrete sidewalks and block walls. The asphalted areas are pollution-generating, while the impervious sidewalk area is non-pollution-generating. The total pollution-generating impervious area on the site is greater than 5,000 square feet and the total pollution-generating pervious area on the site is less than 3/4 acre. Water quality infrastructure is required for the new pollution-generating impervious surfaces (PGIS) on site, or for an equivalent area of PGIS.

Water will flow into curb inlets or catch basins that will be connected by 12-inch pipes. These inlets will flow into perforated pipes, which will infiltrate runoff via graveled infiltration trenches below the sidewalks. The pipes will be 12-inch perforated pipe to distribute flow to the infiltration gravel below. A maximum length of roadway, sidewalk, and adjacent driveway of approximately 750 feet, with a width of half of the right of way, will be tributary to each perforated pipe section and infiltration trench. The maximum area tributary to one trench is approximately 17,000 square feet of tributary area (0.41 ac). The required infiltration trench length for this tributary area is approximately 110 feet. As mentioned, the infiltration trenches will nearly all be 150 feet or more in length. The perforated pipes within the trenches will be laid at a flat slope to facilitate infiltration. Overflows are not anticipated, as the infiltration trenches have been oversized by a factor of at least 1.5, and in most cases 2 or more, based on the least

favorable infiltration rate found on site of 3.9 in/hr. The infiltration rate throughout most of the site is in excess of this.

The 12-inch conveyance pipes will convey flows of up to 0.1861 cfs (the 100-year runoff from the maximum tributary area of 750' by 16'). Using Manning's equation, the minimum slope to convey this flow is less than 0.01 percent. The pipes will be laid at a slope of 0.5 percent or greater throughout the project area, so the conveyance system will be adequate for the 100-year storm.

SECTION F – CSWPPP ANALYSIS AND DESIGN

Best management practices will be used to control runoff from the project area. A Draft Construction Stormwater Pollution Prevention Plan (CSWPPP) has been included in Appendix C of this Report. The CSWPPP includes an Erosion Sediment Control Plan (ESC) which describes which BMPs will be utilized throughout this project. The CSWPPP also includes a Stormwater Pollution Prevention and Spill Plan (SWPPP) which covers measures intended for the unlikely event of a spill on the project site as well as necessary means to keep hazardous construction materials from entering nearby surface water systems. The Contractor can use the Draft CSWPPP to prepare the CSWPPP that will be followed on the construction site.

SECTION G – SPECIAL REPORTS AND STUDIES

Draft Geotechnical Report – West Fir Street Rehabilitation: North 5th Avenue to North Sequim Avenue, Sequim, WA; PanGEO, Inc., January 2016.

This report is included as Appendix A.

SECTION H – OTHER PERMITS

Permits required for this project include the following:

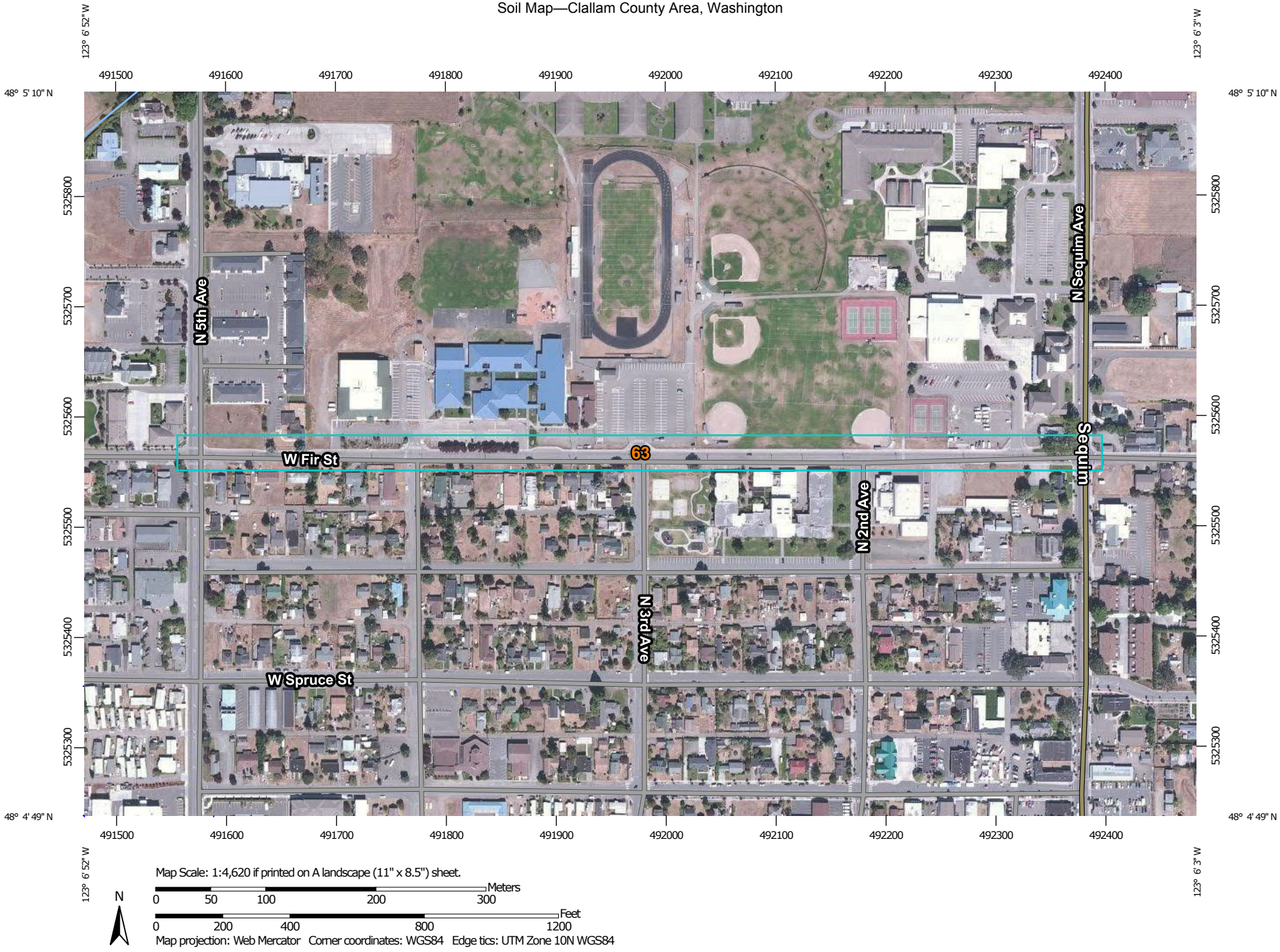
- SEPA
- Right-of-Way/Site Construction Permit, City of Sequim
- General Construction Stormwater Permit, Department of Ecology

SECTION I – OPERATIONS AND MAINTENANCE MANUAL

Infiltration trenches and a bioretention facility will be constructed for this project. A copy of the Department of Ecology recommended maintenance requirements for these facilities has been included as Appendix D.

SECTION J – BOND QUANTITIES

A Payment and Performance Bond will be required from the Contractor to complete the work intended for this site.



Map Scale: 1:4,620 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 50 100 200 300

Feet: 0 200 400 800 1200

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Clallam County Area, Washington
Survey Area Data: Version 12, Sep 28, 2015

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jul 9, 2010—Sep 3, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Clallam County Area, Washington (WA609)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
63	Sequim very gravelly sandy loam	6.7	100.0%
Totals for Area of Interest		**6.7**	**100.0%**

APPENDIX A

GEOTECHNICAL REPORT

GEOTECHNICAL REPORT
West Fir Street Rehabilitation
Sequim, Washington

PROJECT NO. 14-167
January 2016

Prepared for:

Gray & Osborne, Inc.
CONSULTING ENGINEERS

PanGEO INCORPORATED

Geotechnical & Earthquake Engineering Consultants

PanGEO INCORPORATED
Geotechnical & Earthquake Engineering Consultants

January 4, 2016
Project No. 14-167

Ms. Tamara Nack, P.E.
Gray & Osborne, Inc.
701 Dexter Avenue North, Suite 200
Seattle, Washington 98109

Subject: **Geotechnical Report**
West Fir Street Rehabilitation: North 5th Avenue to North Sequim Avenue
Sequim, Washington
G&O #14538

Dear Ms. Nack:

As requested, PanGEO Inc. completed a geotechnical engineering study to support the design and construction of the proposed West Fir Street rehabilitation project in the City of Sequim, Washington. The results of our study and our recommendations are summarized in the attached report. In summary, the near surface soils at our boring locations generally consist of medium dense to dense gravel with a varying silt and sand content that can be compacted to provide a suitable pavement and sidewalk subgrade. Hot mix asphalt on a crushed surfacing course is considered an appropriate pavement option for this project. Details and the basis of our pavement analysis are outlined in this report. Furthermore, we anticipate that infiltration of stormwater will be feasible from the geotechnical engineering perspective due to the presence of relatively clean native gravel and sand at shallow depths.

Please call if you have any questions.

Sincerely,

Siew L. Tan, P.E.
Principal Geotechnical Engineer

3213 Eastlake Avenue East, Suite B
Seattle, WA 98102
Tel (206) 262-0370
Fax (206) 262-0374

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION

As requested, PanGEO completed a geotechnical engineering study to support the design efforts for the West Fir Street rehabilitation project in Sequim, Washington. Our work was performed in general accordance with our proposal dated May 27, 2014, and included conducting a site reconnaissance, advancing six borings, completing a laboratory testing program, and developing the conclusions and recommendations presented in this report.

2.0 SITE AND PROJECT DESCRIPTION

The project alignment extends along the section of West Fir Street located between North 5th Avenue and North Sequim Avenue approximately as indicated in the attached Figure 1, Vicinity Map. Land use along the project alignment includes Sequim High School, Helen Haller Elementary School, School District No. 323 facility buildings, a Boys & Girls Club, and residential properties.

Between North 5th Avenue and North Sequim Avenue, West Fir Street is a two-lane asphalt-paved roadway. Currently, sidewalks/pedestrian improvements within the project alignment are limited to the north side of West Fir Street, except for an approximately 300 foot section on the south side of West Fir Street just west of North Sequim Avenue. Topography along the project alignment is essentially flat. As such, we anticipate grading for this project will be minimal.

We understand this project will likely include complete reconstruction of the pavement and sidewalks, and installation of new underground utilities. The inverts of the proposed utilities may be as deep as 10 feet. We understand that, if feasible, stormwater runoff disposal along the project area will be provided by infiltration trenches within the right-of-way. We understand the bottom of the infiltration facilities will likely be on the order of 9 feet below grade.

As seen in Plates 1 through 4 on the following page, the pavement along the alignment appears to be in generally poor condition with alligatoring and rutting found along utility trenches, particularly in the north half of the road in the vicinity of an existing irrigation line.

Plate 1. West Fir Street, facing west in the vicinity of BH-1.

Plate 2. West Fir Street just west of North 2nd Avenue, facing west.

Plate 3. West Fir Street in the vicinity of BH-5, facing west.

Plate 4. West Fir Street in the vicinity of BH-6 facing west.

3.0 SUBSURFACE EXPLORATIONS

3.1 CURRENT EXPLORATIONS

Six borings (BH-1 through BH-6) were drilled along the project alignment on August 21, 2014. The borings were located in the field by taping from existing site features and are indicated on Figures 2 and 3. The borings were advanced to depths of 7½ to 13½ feet below the existing grade.

The borings were drilled using an EC-85 trailer-mounted drill rig owned and operated by Boretec1 of Bellevue, Washington. The drill rig was equipped with 6-inch outside diameter hollow stem augers. Soil samples were obtained from the borings at 2½- and 5-foot depth intervals in conjunction with Standard Penetration Test (SPT) sampling methods in general accordance with ASTM test method D1586, in which the samples are obtained using a 2-inch outside diameter split-spoon sampler. In addition, a 3¼-inch outside diameter sampler was also used in gravelly deposits in an attempt to recover a more representative soil sample. The sampler was driven into the soil a distance of 18 inches using a 140-pound weight falling a distance of 30 inches. The number of blows required for each 6-inch increment of sampler penetration was recorded. The number of blows required to achieve the last 12 inches of sample penetration is defined as the SPT N-value. The N-value provides an empirical measure of the relative density of cohesionless soil, or the relative consistency of fine-grained soils.

A geologist from PanGEO was present during the field exploration to observe the drilling, to assist in sampling, and to describe and document the soil samples obtained from the borings. The soil samples were described using the system outlined on Figure A-1 in Appendix A. The summary boring logs are included in Appendix A.

3.2 PREVIOUS EXPLORATIONS

In addition to the current borings, we also reviewed the results of previous explorations that PanGEO conducted for the Sequim Civic Center located on the north side of West Cedar Street just west of North Sequim Avenue that was under construction at the time of our study. The location of the Sequim Civic Center project is shown on Figure 1, Vicinity Map. Explorations for Sequim Civic Center baseline geotechnical report included drilling five test borings and conducting one small-scale Pilot Infiltration Test (PIT) in June, 2013.

4.0 LABORATORY TESTING

Representative soil samples were collected from the borings were submitted for Cation Exchange Capacity (CEC) testing. The CEC tests were performed using USEPA Method 9080. The results are presented in Section 7.4.3 of this report, and the raw laboratory test data is included in Appendix B. In addition, grain size distribution analyses were performed on select samples in general accordance with ASTM D-422. The results of the grain size analyses are included in in Appendix B of this report.

5.0 EXISTING PAVEMENT AND SUBGRADE CONDITION

As depicted in Plates 1 through 4 above, the pavement along the alignment generally appears to be in generally poor condition. All of our borings were drilled through the existing pavement to determine the existing pavement section. The pavement sections encountered at these locations are provided in Table 1 below. Based on the absence of a crushed rock layer at our boring locations, it appears that the existing asphalt was placed directly on the subgrade soils.

Table 1 – Existing Pavement Sections

Boring Location	Asphalt Thickness (in.)	Crushed Rock Thickness (in.)
BH-1	4 to 4½	0
BH-2	3½ to 4	0
BH-3	2½ to 3	0
BH-4	4	0
BH-5	2½	0
BH-6	3	0

SPTs conducted directly beneath the existing asphalt at our boring locations indicated that the pavement subgrade was largely in a medium dense to very dense condition with SPT N values typically ranging from 31 to 52 blows per foot. However, at BH-4 the subgrade soil was in a loose to medium dense condition with a SPT N value of 10 blows per foot.

6.0 SUBSURFACE CONDITIONS

6.1 GEOLOGY

The downtown Sequim area is located within the relatively level area known as the Sequim Prairie, which consists of flood plain terrace deposits of an ancestral Dungeness River (Schasse et al., 1998). Review of the Geologic Map of the Sequim 7.5-minute Quadrangle indicates that the surficial geologic unit in the vicinity of the site is older alluvium (Map Unit Qoa). Schasse describes the older alluvium deposits near Sequim as cobble gravels. In addition, this area was covered by the Juan de Fuca lobe ice sheet during the Cordilleran Ice advances of the Quaternary period. Schasse indicates that the mapped older alluvium may be up to 70 feet thick in the project area, and commonly overlies glacial till of the Vashon glacial stade (Map Unit Qgt_v).

6.2 SOILS

In general, the soil conditions encountered in our test borings are consistent with the mapped geology discussed in Section 6.1 of this report.

Fill – Directly beneath the existing asphalt at BH-1, BH-2, and BH-4, loose to very dense, silty gravel with sand to silty sand with gravel that may be existing fill was encountered. The thickness of the possible fill material ranged from 6 inches to 1 foot. This unit appears to be absent at the other three test boring locations.

Older Alluvium – Underlying the possible fill material at BH-1, BH-2, and BH-4, and underlying the existing asphalt at the remaining boring locations, dense to very dense granular deposits ranging from well to poorly graded gravel with a varying silt and sand content to well to poorly graded sand with a varying silt and gravel content were encountered. The upper 2 to 3 feet of this soil unit at BH-4 was weathered to a loose to medium dense condition. We interpret this deposit as the mapped older alluvium. Based on the drill action and our observations of the drill cuttings, abundant cobbles and possible small boulders are present within this soil unit. This soil unit was encountered to the maximum depth explored at each of our current test borings. In addition, the older alluvium soil unit was encountered to 40-plus feet below grade at our borings for the Sequim Civic Center project.

6.3 GROUNDWATER

Groundwater was not encountered at the time of drilling in the borings drilled for this project. However, the groundwater table was encountered between approximately 36 and 39 feet below grade at the time of our study for the Sequim Civic Center project in June, 2013.

It should be noted that groundwater elevations and seepage rates may vary depending on the season, local subsurface conditions, and other factors. Groundwater levels are normally highest during the winter and early spring.

7.0 CONCLUSIONS AND RECOMMENDATIONS

7.1 PAVEMENT DESIGN

We understand it is planned to reconstruct the pavement along the project alignment. It is our opinion that the new hot mix asphalt (HMA) pavement may be supported on crushed surfacing

base course (CSBC) or a combination of CSBC and crushed surfacing top course (CSTC). The following sections outline our pavement design recommendations.

7.1.1 Design Traffic Level

Based on information provided by Gray & Osborne, we understand that in 2012, the average daily traffic (ADT) for the project alignment is 2,200 vehicles (both lanes combined) and the projected 2032 ADT is approximately 6,000 vehicles. Approximately 1% of the 2012 ADT is truck traffic and 50 are school busses. The projected 2032 ADT assumes 1% of the traffic volume is truck traffic and 75 are school busses.

The 18-kip Equivalent Single Axle Loads (ESAL) for a 20-year design period (i.e. 2014 to 2034) was estimated based on the ADT, school bus, and truck traffic discussed above, an assumed annual growth of approximately 2% for school busses and 5% for truck traffic, and the estimated ESAL per axle class outlined in the WSDOT pavement design manual. Based on these parameters, the calculated total design ESAL for the project alignment is approximately 630,000 for both lanes, or about 315,000 per lane.

It should be noted that for the pavement options described below, the actual pavement performance over the design period assumed in our analysis would depend on a number of factors, including the actual traffic loading conditions. The recommended pavement sections will need to be revised if the traffic level is significantly different from the estimated value.

7.1.2 Parameters for Pavement Design

The pavement analysis was performed using the 1993 AASHTO pavement design methodology using the following parameters:

Pavement Design life	20 years
Reliability	85%
Overall Standard Deviation	0.5
Design Serviceability Loss (ΔPSI)	1.5
Drainage Coefficient	1.0
Structural Coefficient: HMA	0.44
Structural Coefficient: CSBC/CSTC	0.14

Resilient Modulus for Subgrade	12,500 psi for compacted subgrade

For our pavement analysis, we assume that the new pavement will be constructed on dense older alluvium soils. Based on our prior experience with similar soil conditions, we estimate that a resilient modulus (M_R) of 12,500 pounds per square inch (psi) is appropriate for the on-site soils provided they are compacted to the project requirements for structural fill.

7.1.3 Recommended Pavement Section

It is our opinion that the new pavement may consist of HMA supported on CSBC/CSTC. Our recommendations for reconstructing project alignment with HMA over CSBC/CSTC are presented in Table 2, below. The HMA should conform to section 9-03.8(2) of the 2014 WSDOT *Standard Specifications*. Crushed surfacing should conform to section 9-03.9(3) of the 2014 WSDOT *Standard Specifications*.

Table 2 - Flexible Pavement Section
(W Fir St: N 5th Ave to N Sequim Ave)

Material Description	New Pavement Section Recommended Minimum Thickness (inches)
HMA	4
CSBC/CSTC	6

The pavement sections recommended above are based on the assumption the subgrade will be adequately compacted. As a minimum, prior to placing the CSBC/CSTC, the upper 12 inches of the subgrade should be compacted to at least 95% of its maximum dry density (Modified Proctor, ASTM D1557). Please note that the near surface site soils are moisture sensitive, and can become difficult to compact when wet. In the event that the subgrade becomes unstable and compaction criteria cannot be achieved due to excess moisture content of the subgrade, we recommend that a geogrid layer (Tensar TX140, or better) be placed on the subgrade before placing the CSBC.

If the existing pavement is to be recycled and used in the road prism, it should be pulverized by a method that limits damage or dislodging of the material below the pavement. The pulverized asphalt should be blended with CSBC/CSTC, in accordance with Section 9-03.21 of the 2014 WSDOT *Standard Specifications,* to be considered an equivalent to CSBC/CSTC. Alternatively,

the pulverized asphalt need not be blended if it is not going to be considered as CSBC/CSTC in the pavement section.

7.2 SUBGRADE PREPARATION FOR PAVEMENTS AND CONCRETE SIDEWALK

Based on the results of our field exploration, it is our opinion that the near-surface site soils are considered adequate for supporting the proposed road rehabilitation and sidewalks provided that the subgrade is adequately prepared. Site preparation should begin with removal of the existing pavements, topsoil, vegetation, root balls, debris, deleterious material, and unsuitable soil from the area of the proposed improvements and excavating to the design subgrade elevation, where applicable.

Based on the results of our test borings, we anticipate silty to relatively clean sand and gravel fill and older alluvium soils to be present below the pavement widening, curbs, and sidewalks. Following excavations to the subgrade level and removal of the unsuitable soils, the exposed subgrade should be moisture conditioned, if necessary, and compacted to a firm condition. The upper 12 inches of material should be compacted to at least 95 percent of the maximum dry density, as determined by test method ASTM D 1557 (Modified Proctor).

Please note that the near surface site soils are moisture sensitive, and can become difficult to compact when wet. In the event that the subgrade becomes unstable and compaction criteria cannot be achieved due to excess moisture content of the subgrade, we recommend overexcavating the unstable soil to competent soil and backfilling the overexcavation with adequately compacted Gravel Borrow or CSBC/CSTC.

Any soft, yielding areas or organic-rich soils identified during the compaction process should be over-excavated and backfilled with properly compacted CSBC/CSTC, as described in Section 9-03.9(3) of the 2014 WSDOT *Standard Specifications*, or Gravel Borrow as described in Section 9-03.14 (1) of the *Standard Specifications*. The subgrade preparation should be observed by an individual experienced with earthwork construction, to verify the adequacy of the prepared subgrade.

We recommend that a leveling course consisting of at least 2 inches of CSBC/CSTC compacted to a dense condition be placed directly below concrete sidewalks to provide a level and firm uniform support. Pulverized asphalt may also be considered for use as a leveling course to support sidewalks, provided it is adequately compacted.

7.3 SIGNAL POLE AND LUMINAIRE FOUNDATIONS

It is our understanding that traffic signal poles or luminaires may be installed as part of the project. Based on the subsurface conditions encountered at our boring locations, medium dense to dense silty to relatively clean sand and gravel deposits with cobbles are anticipated to be encountered in signal pole or luminaire foundation excavations. It should be noted that due to the granular nature of the soil and the potential for cobbles, boulders, temporary casing may be needed to prevent caving of augured holes. Alternatively, open excavations may be need if cobbley soils preclude the use of an auger to drill the signal pole foundations. In all cases, however, the pole foundations should be sufficiently embedded into competent soil to provide resistance to lateral loads and the resulting overturning moments. If the signal pole foundations need to be backfilled, structural fill should be compacted to at least 95 percent of the maximum dry density, as determined by test method ASTM D 1557 (Modified Proctor). Table 4 below presents our recommend geotechnical parameters that should be incorporated into the sizing of the signal pole and luminaire foundations.

Table 3 - Recommended Signal Pole Design Parameters for Foundations in Medium Dense to Dense Sand and Gravel

Geotechnical Design Parameter	
Allowable Lateral Bearing Pressure	2,000 psf
Allowable Passive Pressure (applied over 2 times shaft diameter)	350 pcf
Allowable Soil-Shaft friction	500 psf

7.4 INFILTRATION EVALUATION

Based on the presence of relatively clean older alluvium deposits encountered at shallow depths in our borings drilled along the project alignment, it is our opinion that storm water infiltration should be feasible at the site. The infiltration rates of the site soils were assessed by using the grain size analysis method described in Section 7.4.1. Recommended long-term (design) infiltration rates for the proposed infiltration facility and additional discussions are provided in Section 7.4.2.

7.4.1 Design Infiltration Rate Based on Grain Size Analysis

Design infiltration rates of soils not consolidated by glacial advance such as alluvium or recessional outwash may be assessed based on grain size distributions, as outlined in the *Stormwater Management Manual for Western Washington* (SMMWW, WSDOE, 2012). The method estimates the initial saturated hydraulic conductivity (K_{sat}) using the following relationship:

$$\log_{10}(K_{sat}) = -1.57+1.9D_{10}+0.015D_{60}-0.013D_{90}-2.08f_{fines}$$

Three partial correction factors are then applied to K_{sat} value to estimate the long-term (design) infiltration rate as discussed in the following section.

7.4.2 Recommended Design Infiltration Rates and Discussion

The correction factor for site variability (CF_v) is selected based on the number of locations tested and the consistency of the underlying soil conditions and ranges from 0.33 to 1.0 (no correction factor). Based on the varying fines content of the older alluvium, the potential for alluvial soils to vary over relatively short distances, and based on our experience and engineering judgment, we recommend a correction factor of 0.5 for site variability.

The test method correction factor (CF_t) is intended to account for the uncertainty of the test method and the scale of test versus the size of the facility. The SMMWW applies a correction factor of $CF_t = 0.4$ when using the grain size method to estimate the long-term infiltration rate.

An influent control correction factor (CF_m) of 0.9 is intended to account for a reduction in infiltration capacity due to clogging from siltation and the build-up of biological material.

Based on the discussions above, a total correction factor of 0.18 (i.e., $CF_v \times CF_t \times CF_m = 0.5 \times 0.4 \times 0.9 = 0.18$) was applied to the K_{sat} value to get the estimated long-term infiltration rates presented in Table 4.

Table 4 – Estimated Long-Term Infiltration Rates for West Fir Street

W Fir Street Sample Location, Depth	Correction Factor ($CF_v \times CF_t \times CF_m$)*	Long-Term Infiltration Rate (inches/hour)
BH-2, 2.5’ to 4’	0.18	5.7
BH-2, 10’ to 10.9’	0.18	3.5
BH-3, 5’ to 6’	0.18	3.9

BH-3, 10’ to 11’	0.18	5.3
BH-4, 2.5’ to 4’	0.18	8.8
BH-4, 5’ to 6.5’	0.18	12.7**
BH-4, 10’ to 10.4’	0.18	2.0
BH-5, 2.5’ to 4’	0.18	4.7
BH-5, 5’ to 6.5’	0.18	12.3**
BH-5, 10’ to 11.5’	0.18	11.4**

*$CF_v = 0.5$, $CF_t = 0.4$, $CF_m = 0.9$

**We recommend a maximum infiltration rate be limited to 10 inches/hour for design.

For comparison, the results of a small-scale PIT conducted 4 feet below grade at the Sequim Civic Center project in similar soil conditions yielded an uncorrected constant head infiltration rate of 17 inches per hour. When applying correction factors for site variability ($CF_v = 0.5$), test method ($CF_t = 0.5$ for small-scale PIT), and influent control factor ($CF_m = 0.9$), the field infiltration rate would be reduced to a long-term (design) rate of approximately 3.8 inches per hour.

Groundwater Separation: For infiltration facilities, the DOE SMMWW requires a minimum 5-foot separation between the bottom of the infiltration facility and the seasonal high groundwater level. Groundwater was not encountered in the borings drilled along the project alignment at the time of drilling. Furthermore, the groundwater table in our borings drilled for the Sequim Civic Center project was encountered between 36 and 39 feet below grade. Therefore, it is our opinion that the proposed infiltration facility will meet the DOE groundwater separation requirement.

7.4.3 Cation Exchange Capacity

The SMMWW indicates that the cation exchange capacity (CEC) of treatment soils must be considered when determining if the soil can adequately remove the target pollutants. The SMMWW states that the CEC of the treatment soil must be $\geq$5 milliequivalents CEC/100 grams of dry soil. If the treatment soils do not meet this CEC requirement, appropriate mitigation

measures must be implemented. CEC tests were performed on older alluvium samples collected from the borings. The laboratory test results from CEC tests are summarized in Table 5 and the test results are included in Appendix B.

Table 5 – Cation Exchange Capacity Lab Testing Results

Sample Location, Depth	Cation Exchange Capacity (meq/100g)
BH-2, 2.5' to 4'	4.07
BH-3, 5' to 6'	1.15
BH-4, 2.5' to 4'	6.45
BH-4, 5' to 6.5'	4.02
BH-5, 2.5' to 4'	4.40
BH-5, 5' to 6.5'	3.53

7.5 UTILITIES

7.5.1 Trenching

We understand new utilities may be installed as part of this project. The pipe invert is likely no deeper than 10 feet. Based on the borings drilled along the project alignment, it is anticipated that the subgrade soils at the pipe invert along the pipe alignment should consist of dense to very dense relatively clean sand and gravel deposits that should generally provide adequate support for the utility pipes and structures. If soft or unstable soil that cannot be adequately compacted or unsuitable organic material is encountered at the trench bottom, it may be necessary to overexcavate the material and backfill with pipe bedding or CSBC compacted to a dense condition.

Utility trenches greater than 4 feet deep should be properly sloped. Temporary slope recommendations can be found in Section 7.6.3 of this report. Alternatively, conventional trench shoring systems such as trench boxes are considered feasible for this project. For shoring design purposes, the contractor may utilize an equivalent fluid weight of 35 pcf to represent the lateral earth pressures on the shoring. This pressure should be increased for backslopes above the

shoring or to account for soil stockpiles and/or equipment traffic surcharges within a horizontal distance equal to the depth of the excavation.

7.5.2 Pipe Bedding

Pipe bedding material, placement, compaction, and shaping should be in accordance with the project specifications and the pipe manufacturer's recommendations. As a minimum, the pipe bedding material should meet the requirements for Gravel Backfill for Pipe Zone Bedding in section 9-03.12(3) of 2014 WSDOT's *Standard Specifications*. Based on the soils encountered in our borings and based on our previous experience in the project area, we do not anticipate the onsite soils will meet the WSDOT gradation requirements for Gravel Backfill for Pipe Zone Bedding. Bedding material should be placed in accordance with the recommendations provided in section 7-08.3(1)C for Pipe Zone Bedding in the WSDOT's *Standard Specifications* to ensure proper pipe support and protection. The excavated trench bottom should be firm and unyielding or be compacted to such a condition prior to placement of bedding material.

7.5.3 Trench Backfill

The recommendations in this section are in addition to the material reuse and structural fill and compaction recommendations in Sections 7.6.1 and 7.6.2 of this report. In general, the requirements for trench backfill should be in accordance with Section 7-08.3(3) of WSDOT's *Standard Specifications.* The first zone of backfill extending from the bedding material to at least 6 inches above the crown of the pipe should consist of select free-draining granular material to reduce the compaction effort required and resulting stresses on the pipe. The granular material should be well-graded, less than 1½ inch in maximum size, and less than 10 percent passing the No. 200 sieve, such as Gravel Backfill for Pipe Zone Bedding in section 9-03.12(3) of WSDOT's *Standard Specifications* or CSBC.

During placement of the initial lifts, the trench backfill should not be bulldozed into the trench or dropped directly on the pipe. Furthermore, heavy vibratory equipment should not be permitted to operate directly over the pipe until a minimum of 2 feet of backfill has been placed above the crown. The trench backfill material should be placed in 8- to 12-inch, loose lifts and compacted to at least 95% of the Modified Proctor.

7.6 GENERAL EARTHWORK RECOMMENDATIONS

7.6.1 Material Reuse

It is our opinion that the relatively clean sand and gravel encountered in the borings may be considered for use as structural fill to raise grades or as trench backfill, provided the soil can be compacted to the project requirements for structural fill. However, some of the existing fill and the upper portion of the older alluvial sols have a relatively high fines content and are considered moderately moisture sensitive. As such, these soils may not be appropriate for use as structural fill or trench backfill during wet weather.

The limits of reuse of recycled materials such as asphalt are presented in Section 9-03.21 of the 2014 WSDOT *Standard Specifications.*

7.6.2 Structural Fill and Compaction

Imported structural fill, if needed, should consist of clean, free-draining granular soils that are relatively free from organic matter or other deleterious materials. Such materials should be less than 4 inches in maximum dimension, with less than 7 percent fines (portion passing the U. S. Standard No. 200 sieve), as specified in Section 9-03.14(1) of the 2014 WSDOT *Standard Specifications for Road, Bridge, and Municipal Construction.* The fine-grained portion of structural fill soils should be non-plastic. A fines content greater than 7 percent may be acceptable if the earthwork is performed during relatively dry weather and the contractor's methods are conducive to proper compaction of the soil. The use of imported material with a fines content greater than 7 percent should be approved by the project engineer prior to use.

Structural fill should be compacted to 95% of its maximum dry density, as determined using ASTM D1557 (Modified Proctor). The procedure to achieve proper density of a compacted fill depends on the size and type of compacting equipment, soil moisture content, the number of passes, thickness of the layer being compacted, and certain soil properties. In areas where the use of heavy equipment may be restricted, smaller equipment can be used, but the soil must be placed in thin enough layers to achieve the required relative compaction.

7.6.3 Temporary Excavations

We anticipate that excavations for this project will likely be 10 feet deep or less for utility installations. The excavations will largely encounter medium dense to very dense silty gravel with sand and relatively clean gravel with sand that could cave in when not properly sloped or

supported. All temporary excavations should be performed in accordance with Part N of WAC (Washington Administrative Code) 296-155. The contractor is responsible for maintaining safe excavation slopes and/or shoring. Any temporary excavation greater than 4 feet deep should be properly sloped or shored. For planning purposes, it is our opinion that temporary excavations may be sloped as steep as 1H:1V. However, if groundwater is encountered in site excavations, flatter side slopes or temporary shoring may be necessary. The inclination of temporary slopes should be evaluated in the field during construction based on actual observed soil conditions.

7.6.4 Wet Weather Earthwork

In our opinion, because the near surface site soils contain a relatively high amount of fines and are considered moderately moisture sensitive, earthwork construction performed during the drier summer months likely will be more economical. If the earthwork will be performed during wet weather, the on-site subgrade could become saturated and difficult or impossible to adequately compact. Soft subgrade conditions due to inclement weather, disturbance, and poor drainage will require removal of soft or unstable soils and replacement with gravel borrow or CSBC. To reduce the risks of subgrade disturbance due to inclement weather conditions, we recommended that, as a minimum, the following recommendations be incorporated into the contract specifications.

- Earthwork should be performed in small areas to minimize exposure to wet weather. Excavation or the removal of unsuitable soil should be followed promptly by the placement and compaction of clean structural fill.
- The size and type of construction equipment used may have to be limited to prevent soil disturbance.
- During wet weather conditions, the allowable fines content of the gravel borrow should be reduced to no more than 5 percent by weight based on the portion passing ¾-inch sieve. The fines should be non-plastic.
- The ground surface within the construction area should be graded to promote run-off of surface water and to prevent the ponding of water.
- The ground surface within the construction area should be sealed by a smooth drum vibratory roller, or equivalent, and under no circumstances should soil be left uncompacted and exposed to moisture.

- Bales of straw and/or geotextile silt fences should be strategically located to control erosion and the movement of soil.

8.0 LIMITATIONS

We have prepared this report for Gray & Osborne, Inc. and the project design team. Recommendations contained in this report are based on a site reconnaissance, a subsurface exploration program, a laboratory testing program, review of pertinent subsurface information, and our understanding of the project. The study was performed using a mutually agreed-upon scope of work.

Variations in soil conditions may exist between the locations of the explorations and the actual conditions underlying the site. The nature and extent of soil variations may not be evident until construction occurs. If any soil conditions are encountered at the site that are different from those described in this report, we should be notified immediately to review the applicability of our recommendations. Additionally, we should also be notified to review the applicability of our recommendations if there are any changes in the project scope.

The scope of our work does not include services related to construction safety precautions. Our recommendations are not intended to direct the contractors' methods, techniques, sequences or procedures, except as specifically described in our report for consideration in design. Additionally, the scope of our work specifically excludes the assessment of environmental characteristics, particularly those involving hazardous substances.

This report has been prepared for planning and design purposes for specific application to the proposed project in accordance with the generally accepted standards of local practice at the time this report was written. No warranty, express or implied, is made.

This report may be used only by the client and for the purposes stated, within a reasonable time from its issuance. Land use, site conditions (both off and on-site), or other factors including advances in our understanding of applied science, may change over time and could materially affect our findings. Therefore, this report should not be relied upon after 24 months from its issuance. PanGEO should be notified if the project is delayed by more than 24 months from the date of this report so that we may review the applicability of our conclusions considering the time lapse.

It is the client's responsibility to see that all parties to this project, including the designer, contractor, subcontractors, etc., are made aware of this report in its entirety. The use of

information contained in this report for bidding purposes should be done at the contractor's option and risk. Any party other than the client who wishes to use this report shall notify PanGEO of such intended use and for permission to copy this report. Based on the intended use of the report, PanGEO may require that additional work be performed and that an updated report be reissued. Noncompliance with any of these requirements will release PanGEO from any liability resulting from the use this report.

We appreciate the opportunity to be of service.

Sincerely,

Steven T. Swenson, L.G.
Project Geologist

Siew L. Tan, P.E.
Principal Geotechnical Engineer

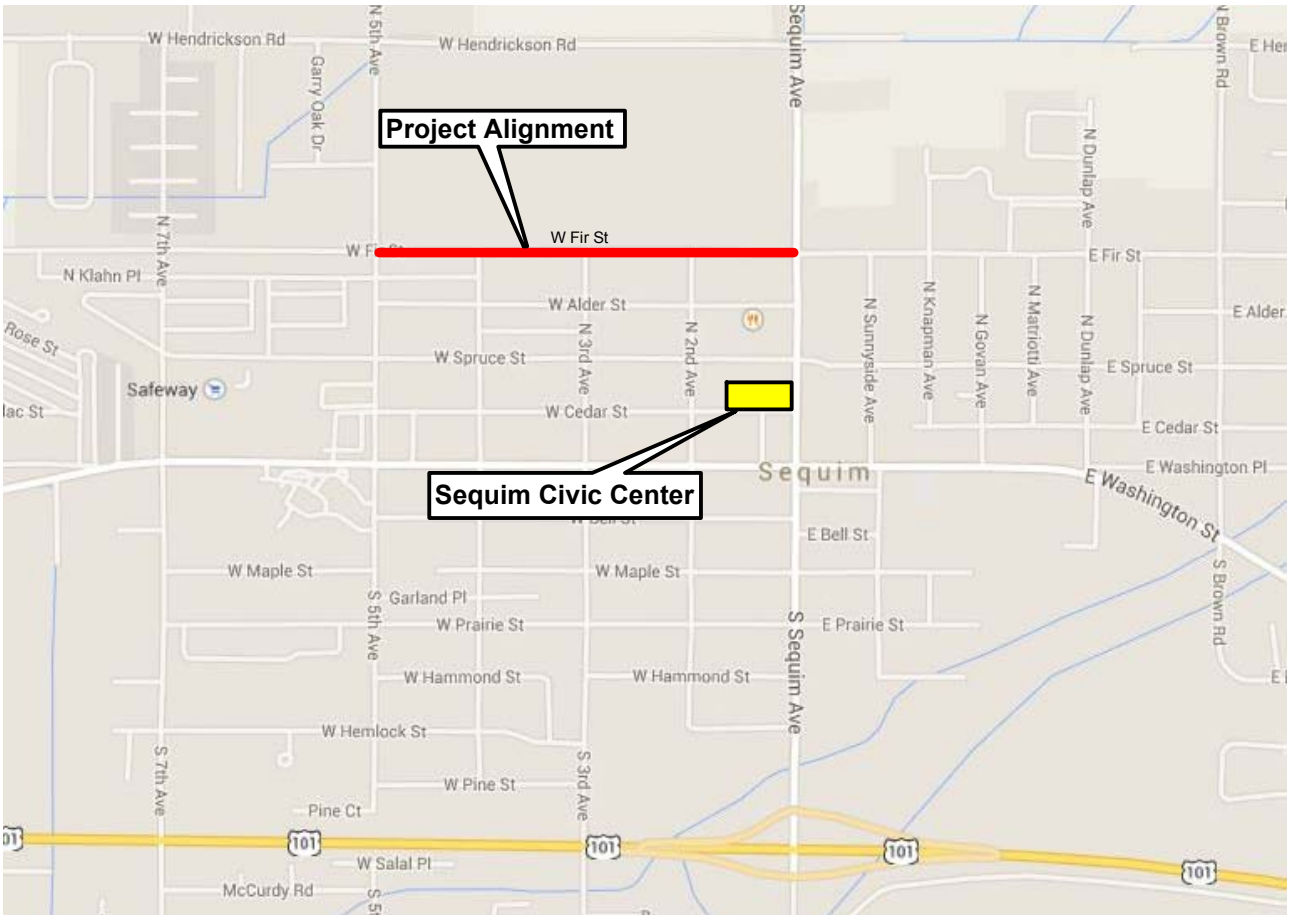
9.0 LIST OF REFERENCES

American Association of State Highway and Transportation Officials, 1993, *AASHTO Guide for Design of Pavement Structures*.

Schasse, H. W.; Logan, R. L., 1998, *Geologic Map of the Sequim 7.5-minute quadrangle, Clallam County, Washington*: Washington Division of Geology and Earth Resources Open File Report 98-7, 22 p., 2 plates.

Washington State Department of Ecology, 2012, *Stormwater Management Manual for Western Washington* Publication.

WSDOT, 2014, *Standard Specifications for Road, Bridges, and Municipal Construction*.



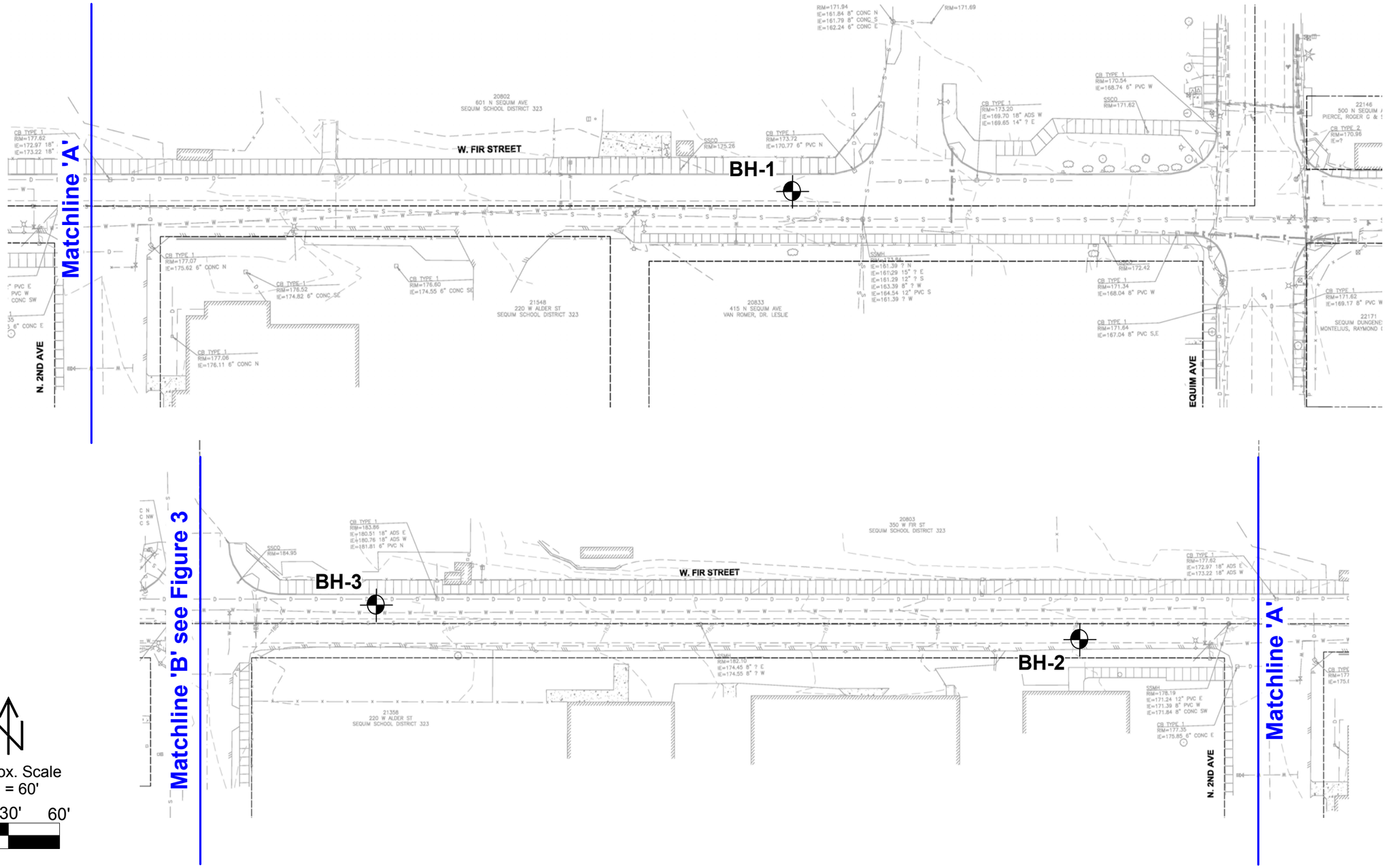
N

No Scale

Image Source: Google Maps

PanGEO INCORPORATED	**West Fir Street Rehabilitation Sequim, WA**	**VICINITY MAP**	
		Project No. **14-167**	Figure No. **1**

14-167 Fig 1 Vicinity.grf 11/6/14 (12:25) STS



Approx. Scale
1" = 60'

0' 30' 60'

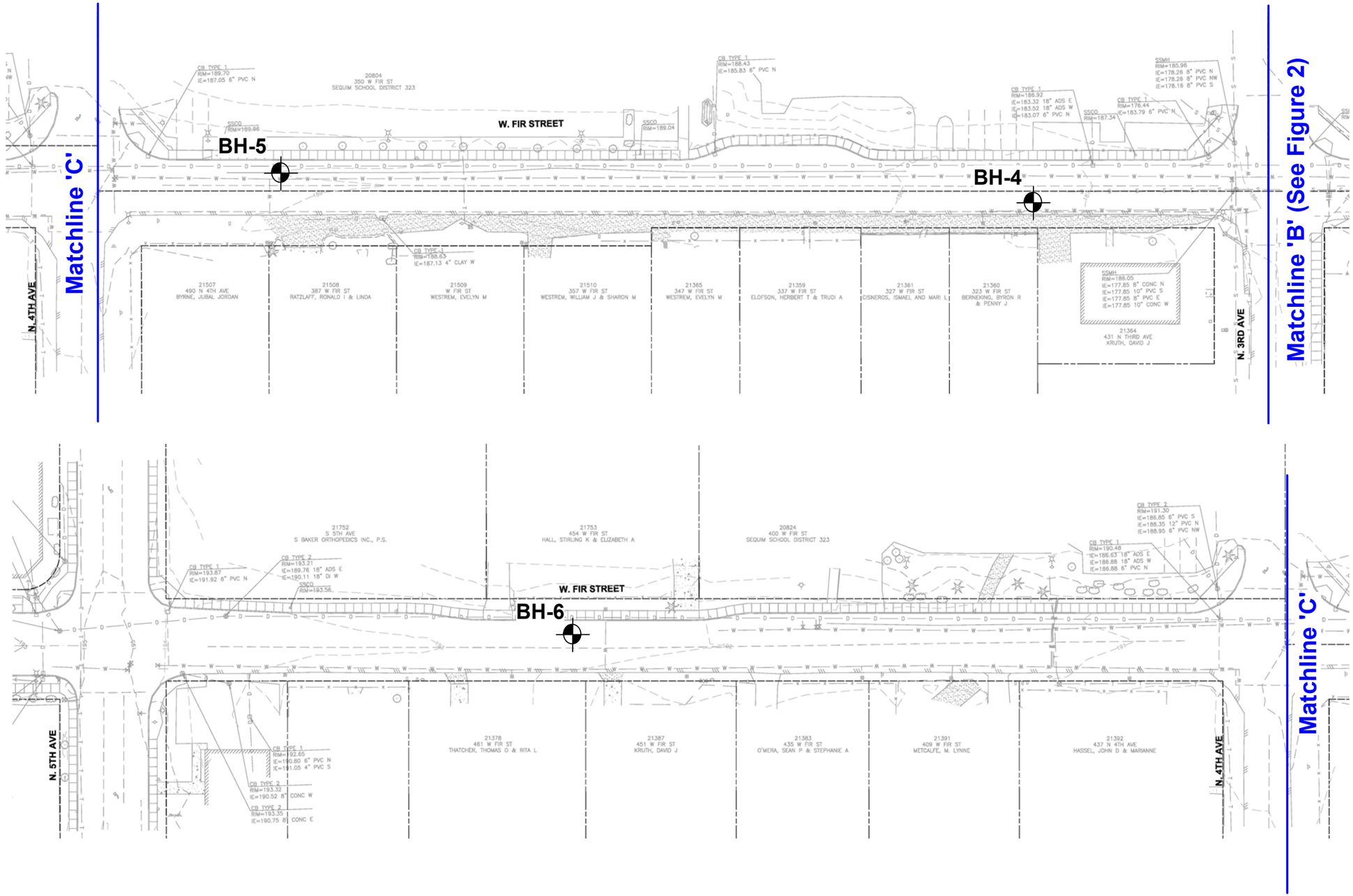
Legend:

Approx. Borehole Location

Note: Base map modified from topographic survey provided by Gray & Osborne.

PanGEO INCORPORATED	**West Fir Street Rehabilitation Sequim, WA**	**SITE AND EXPLORATION PLAN (N Sequim Ave to N 3rd Ave)**
		Project No. **14-167** / Figure No. **2**

14-167 Fig 2 Site Plan.grf 11/6/14 (12:31) STS



Approx. Scale
1" = 60'

0' 30' 60'

Legend:

Approx. Borehole Location

Note: Base map modified from topographic survey provided by Gray & Osborne.

PanGEO INCORPORATED	**West Fir Street Rehabilitation Sequim, WA**	**SITE AND EXPLORATION PLAN (N 3rd Ave to N 5th Ave)**	
		Project No. **14-167**	Figure No. **3**

14-167 Fig 3 Site Plan.grf 11/6/14 (12:30) STS

APPENDIX A

SUMMARY BORING LOGS

RELATIVE DENSITY / CONSISTENCY

SAND / GRAVEL			SILT / CLAY		
Density	SPT N-values	Approx. Relative Density (%)	Consistency	SPT N-values	Approx. Undrained Shear Strength (psf)
Very Loose	<4	<15	Very Soft	<2	<250
Loose	4 to 10	15 - 35	Soft	2 to 4	250 - 500
Med. Dense	10 to 30	35 - 65	Med. Stiff	4 to 8	500 - 1000
Dense	30 to 50	65 - 85	Stiff	8 to 15	1000 - 2000
Very Dense	>50	85 - 100	Very Stiff	15 to 30	2000 - 4000
			Hard	>30	>4000

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS		GROUP DESCRIPTIONS	
Gravel 50% or more of the coarse fraction retained on the #4 sieve. Use dual symbols (eg. GP-GM) for 5% to 12% fines.	GRAVEL (<5% fines)	GW	Well-graded GRAVEL
		GP	Poorly-graded GRAVEL
	GRAVEL (>12% fines)	GM	Silty GRAVEL
		GC	Clayey GRAVEL
Sand 50% or more of the coarse fraction passing the #4 sieve. Use dual symbols (eg. SP-SM) for 5% to 12% fines.	SAND (<5% fines)	SW	Well-graded SAND
		SP	Poorly-graded SAND
	SAND (>12% fines)	SM	Silty SAND
		SC	Clayey SAND
Silt and Clay 50%or more passing #200 sieve	Liquid Limit < 50	ML	SILT
		CL	Lean CLAY
		OL	Organic SILT or CLAY
	Liquid Limit > 50	MH	Elastic SILT
		CH	Fat CLAY
		OH	Organic SILT or CLAY
Highly Organic Soils		PT	PEAT

Notes: 1. Soil exploration logs contain material descriptions based on visual observation and field tests using a system modified from the Uniform Soil Classification System (USCS). Where necessary laboratory tests have been conducted (as noted in the "Other Tests" column), unit descriptions may include a classification. Please refer to the discussions in the report text for a more complete description of the subsurface conditions.

2. The graphic symbols given above are not inclusive of all symbols that may appear on the borehole logs. Other symbols may be used where field observations indicated mixed soil constituents or dual constituent materials.

DESCRIPTIONS OF SOIL STRUCTURES

Layered: Units of material distinguished by color and/or composition from material units above and below

Laminated: Layers of soil typically 0.05 to 1mm thick, max. 1 cm

Lens: Layer of soil that pinches out laterally

Interlayered: Alternating layers of differing soil material

Pocket: Erratic, discontinuous deposit of limited extent

Homogeneous: Soil with uniform color and composition throughout

Fissured: Breaks along defined planes

Slickensided: Fracture planes that are polished or glossy

Blocky: Angular soil lumps that resist breakdown

Disrupted: Soil that is broken and mixed

Scattered: Less than one per foot

Numerous: More than one per foot

BCN: Angle between bedding plane and a plane normal to core axis

COMPONENT DEFINITIONS

COMPONENT	SIZE / SIEVE RANGE	COMPONENT	SIZE / SIEVE RANGE
Boulder:	> 12 inches	Sand	
Cobbles:	3 to 12 inches	Coarse Sand:	#4 to #10 sieve (4.5 to 2.0 mm)
Gravel		Medium Sand:	#10 to #40 sieve (2.0 to 0.42 mm)
Coarse Gravel:	3 to 3/4 inches	Fine Sand:	#40 to #200 sieve (0.42 to 0.074 mm)
Fine Gravel:	3/4 inches to #4 sieve	Silt	0.074 to 0.002 mm
		Clay	<0.002 mm

TEST SYMBOLS

for In Situ and Laboratory Tests listed in "Other Tests" column.

ATT	Atterberg Limit Test
Comp	Compaction Tests
Con	Consolidation
DD	Dry Density
DS	Direct Shear
%F	Fines Content
GS	Grain Size
Perm	Permeability
PP	Pocket Penetrometer
R	R-value
SG	Specific Gravity
TV	Torvane
TXC	Triaxial Compression
UCC	Unconfined Compression

SYMBOLS

Sample/In Situ test types and intervals

- 2-inch OD Split Spoon, SPT (140-lb. hammer, 30" drop)
- 3.25-inch OD Spilt Spoon (300-lb hammer, 30" drop)
- Non-standard penetration test (see boring log for details)
- Thin wall (Shelby) tube
- Grab
- Rock core
- Vane Shear

MONITORING WELL

- Groundwater Level at time of drilling (ATD)
- Static Groundwater Level
- Cement / Concrete Seal
- Bentonite grout / seal
- Silica sand backfill
- Slotted tip
- Slough
- Bottom of Boring

MOISTURE CONTENT

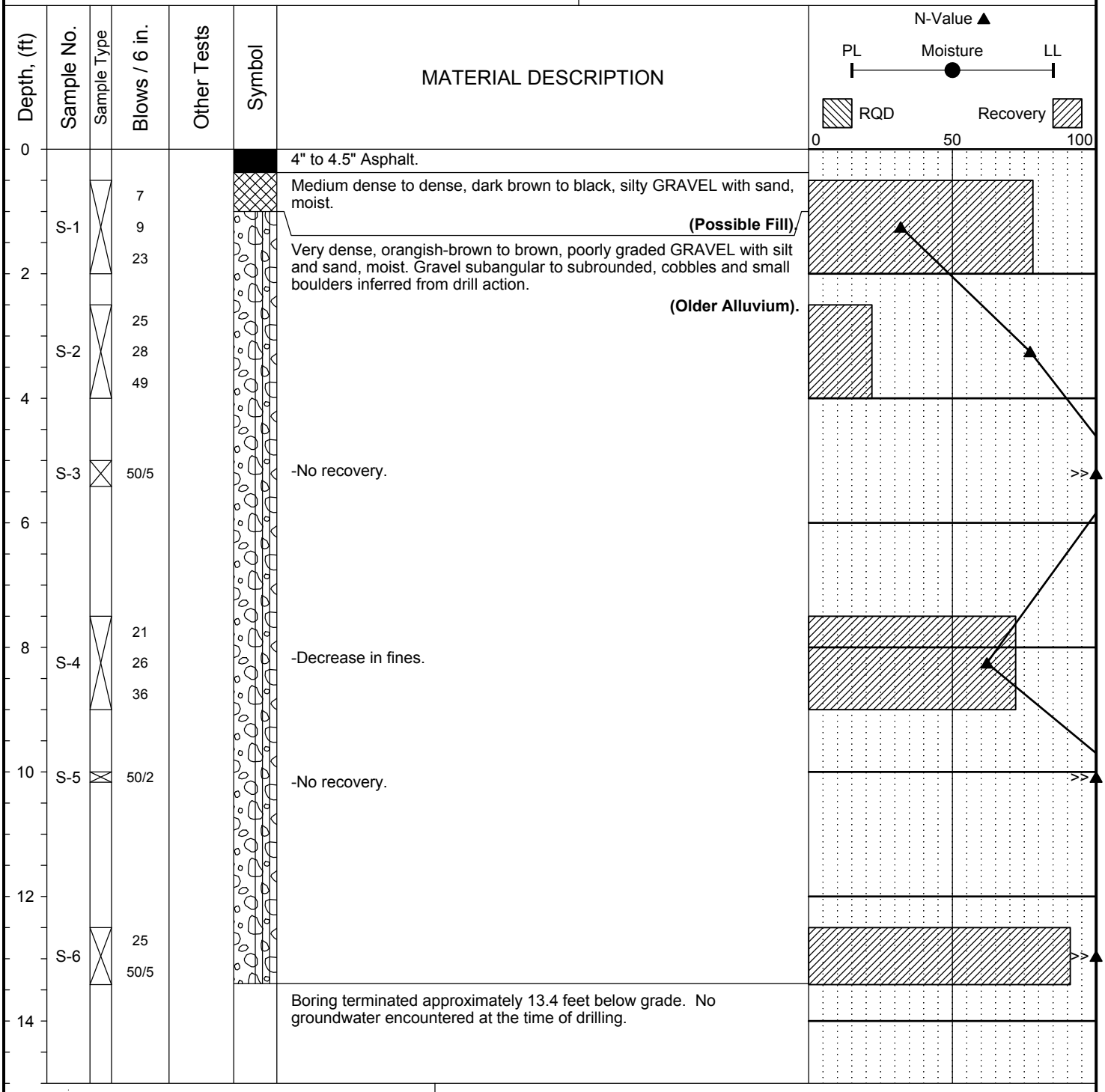
Dry	Dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water

PanGEO INCORPORATED
Phone: 206.262.0370

Terms and Symbols for Boring and Test Pit Logs

Figure A-1

Project:	West Fir Street Rehabilitation	Surface Elevation:	174.0ft
Job Number:	14-167	Top of Casing Elev.:	N/A
Location:	Sequim, WA	Drilling Method:	Hollow Stem Auger
Coordinates:	Northing: , Easting:	Sampling Method:	SPT



Completion Depth:	13.4ft
Date Borehole Started:	8/21/14
Date Borehole Completed:	8/21/14
Logged By:	STS
Drilling Company:	Boretec1, Inc.

Remarks: Boring drilled with an EC-85 trailer-mounted drill rig equipped with safety hammer (cathead mechanism) for SPT.

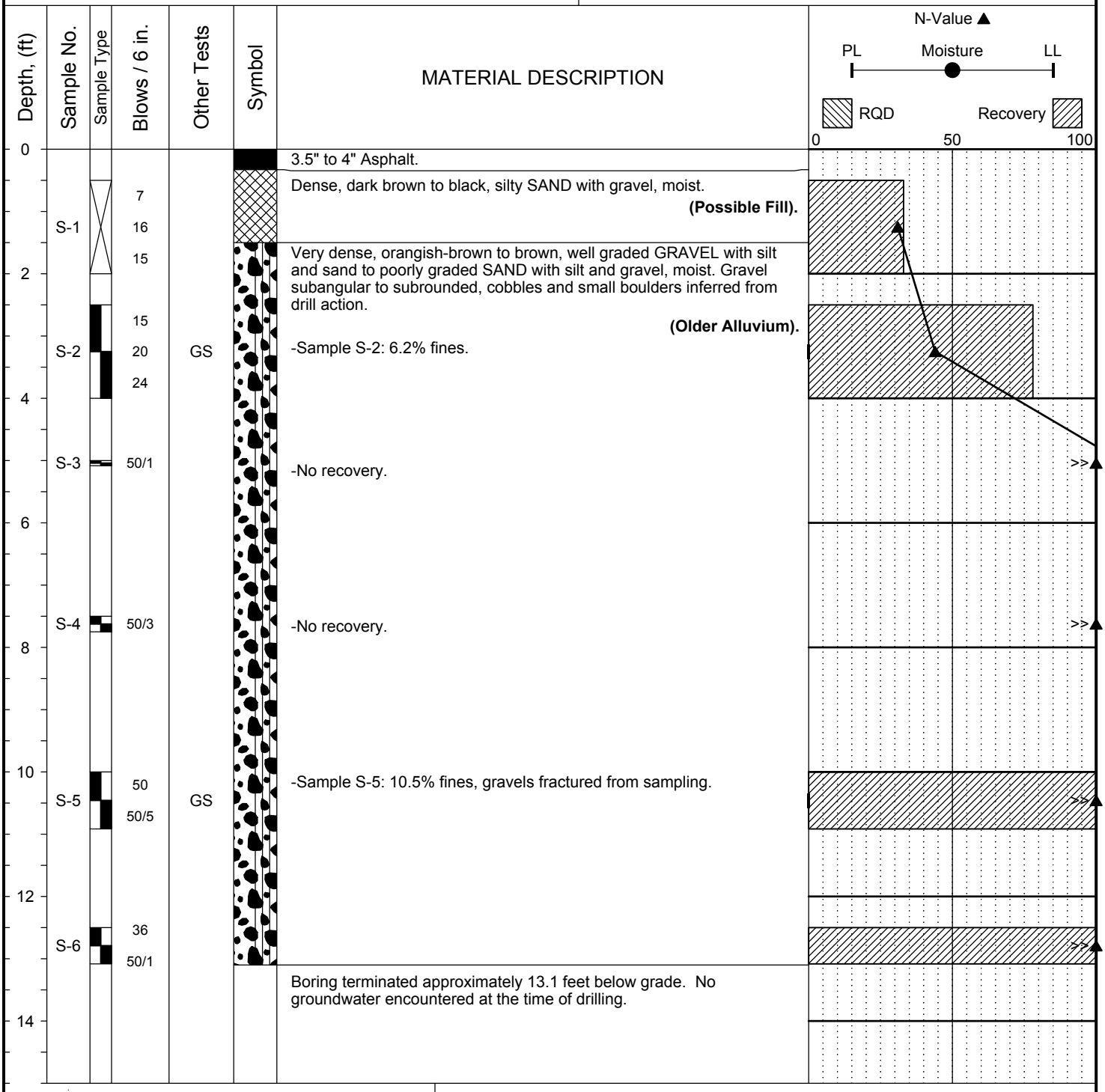
PanGEO INCORPORATED

LOG OF TEST BORING BH-1

Figure A-2

The stratification lines represent approximate boundaries. The transition may be gradual.

Project:	West Fir Street Rehabilitation	Surface Elevation:	179.0ft
Job Number:	14-167	Top of Casing Elev.:	N/A
Location:	Sequim, WA	Drilling Method:	Hollow Stem Auger
Coordinates:	Northing: , Easting:	Sampling Method:	SPT



Completion Depth:	13.1ft
Date Borehole Started:	8/21/14
Date Borehole Completed:	8/21/14
Logged By:	STS
Drilling Company:	Boretec1, Inc.

Remarks: Boring drilled with an EC-85 trailer-mounted drill rig equipped with safety hammer (cathead mechanism) for SPT.

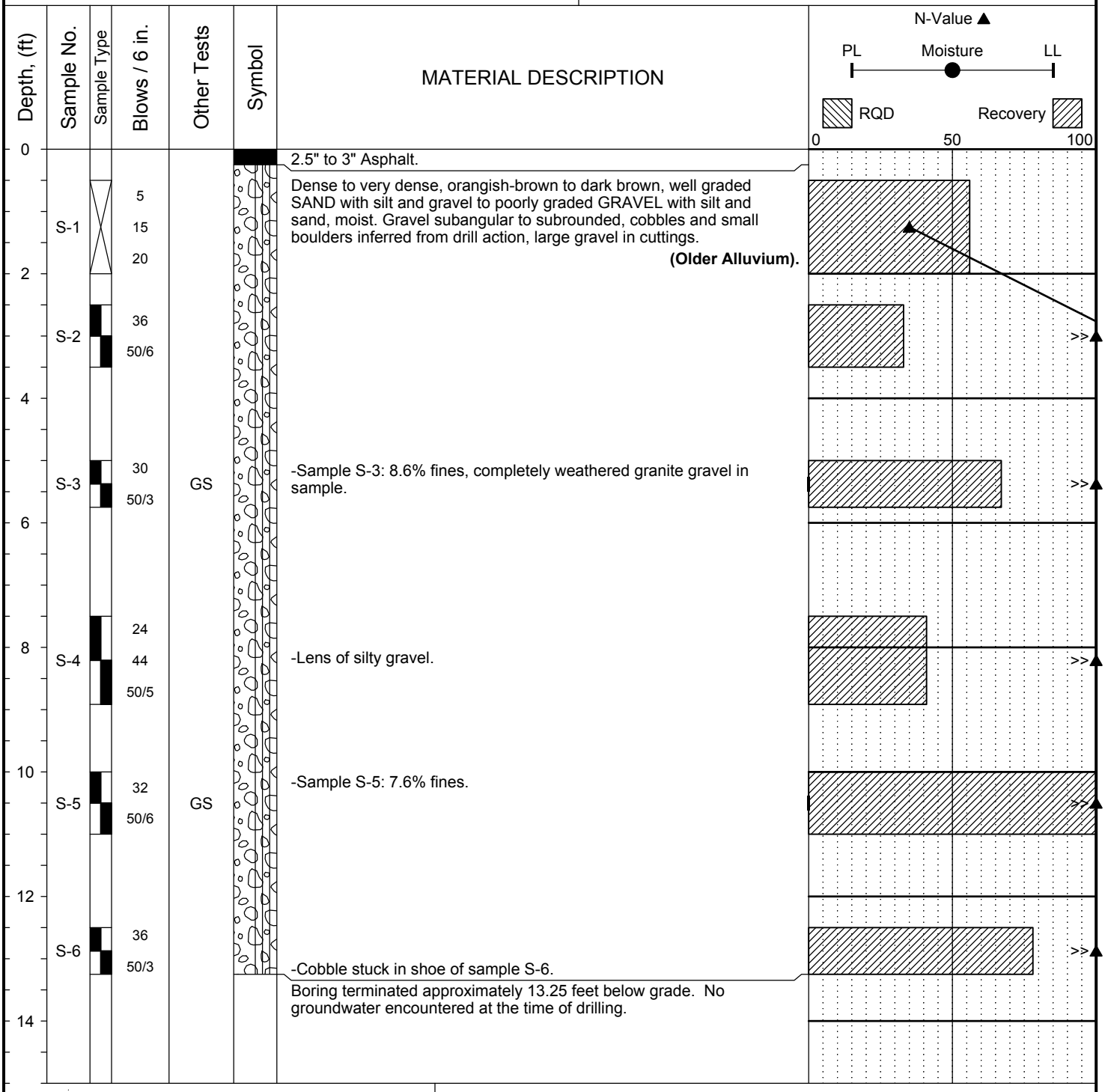
PanGEO INCORPORATED

LOG OF TEST BORING BH-2

Figure A-3

The stratification lines represent approximate boundaries. The transition may be gradual.

Project:	West Fir Street Rehabilitation	Surface Elevation:	184.0ft
Job Number:	14-167	Top of Casing Elev.:	N/A
Location:	Sequim, WA	Drilling Method:	Hollow Stem Auger
Coordinates:	Northing: , Easting:	Sampling Method:	SPT



Completion Depth:	13.3ft
Date Borehole Started:	8/21/14
Date Borehole Completed:	8/21/14
Logged By:	STS
Drilling Company:	Boretec1, Inc.

Remarks: Boring drilled with an EC-85 trailer-mounted drill rig equipped with safety hammer (cathead mechanism) for SPT.

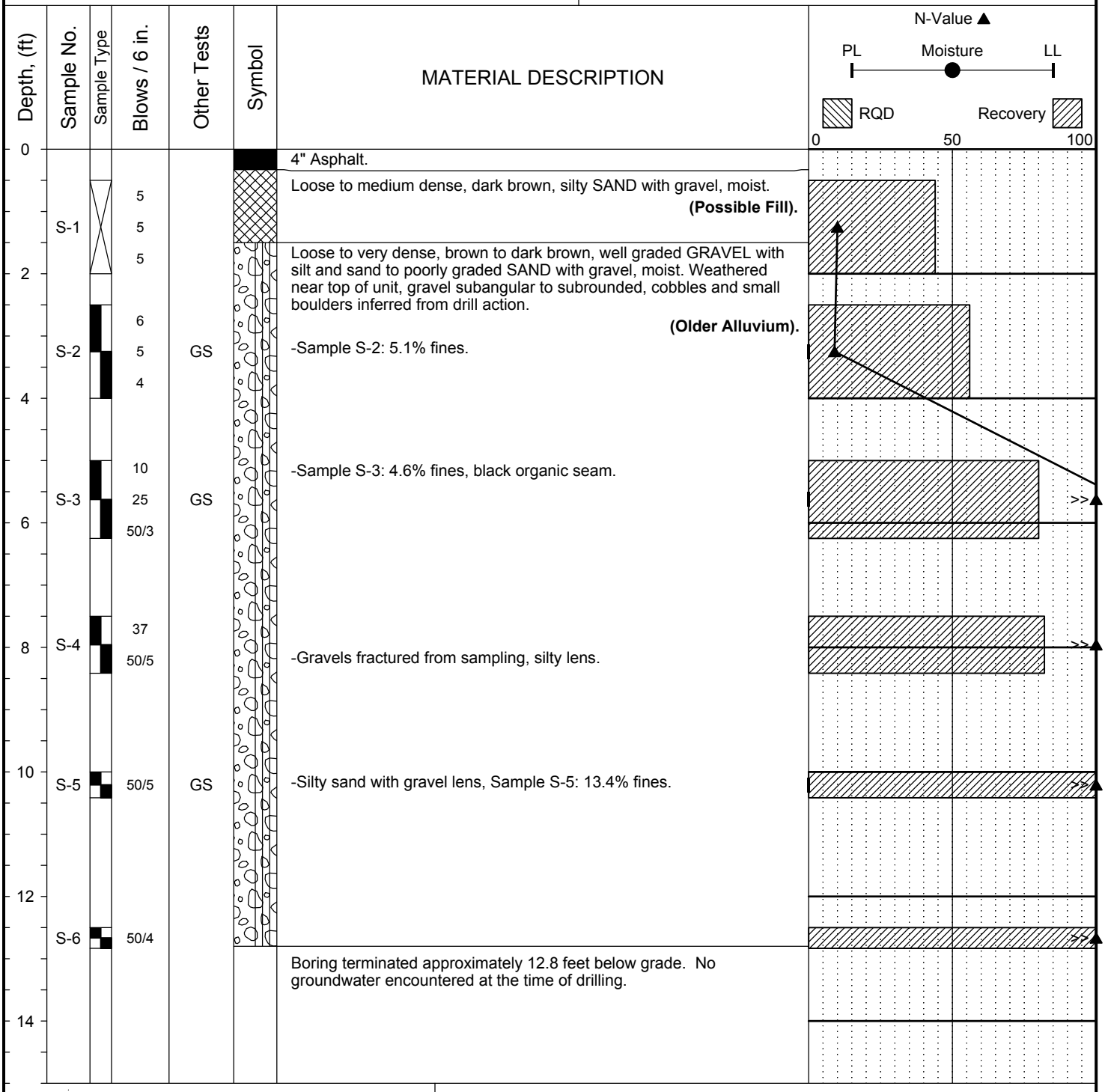
PanGEO INCORPORATED

LOG OF TEST BORING BH-3

Figure A-4

The stratification lines represent approximate boundaries. The transition may be gradual.

Project:	West Fir Street Rehabilitation	Surface Elevation:	187.0ft
Job Number:	14-167	Top of Casing Elev.:	N/A
Location:	Sequim, WA	Drilling Method:	Hollow Stem Auger
Coordinates:	Northing: , Easting:	Sampling Method:	SPT



Completion Depth:	12.8ft
Date Borehole Started:	8/21/14
Date Borehole Completed:	8/21/14
Logged By:	STS
Drilling Company:	Boretec1, Inc.

Remarks: Boring drilled with an EC-85 trailer-mounted drill rig equipped with safety hammer (cathead mechanism) for SPT.

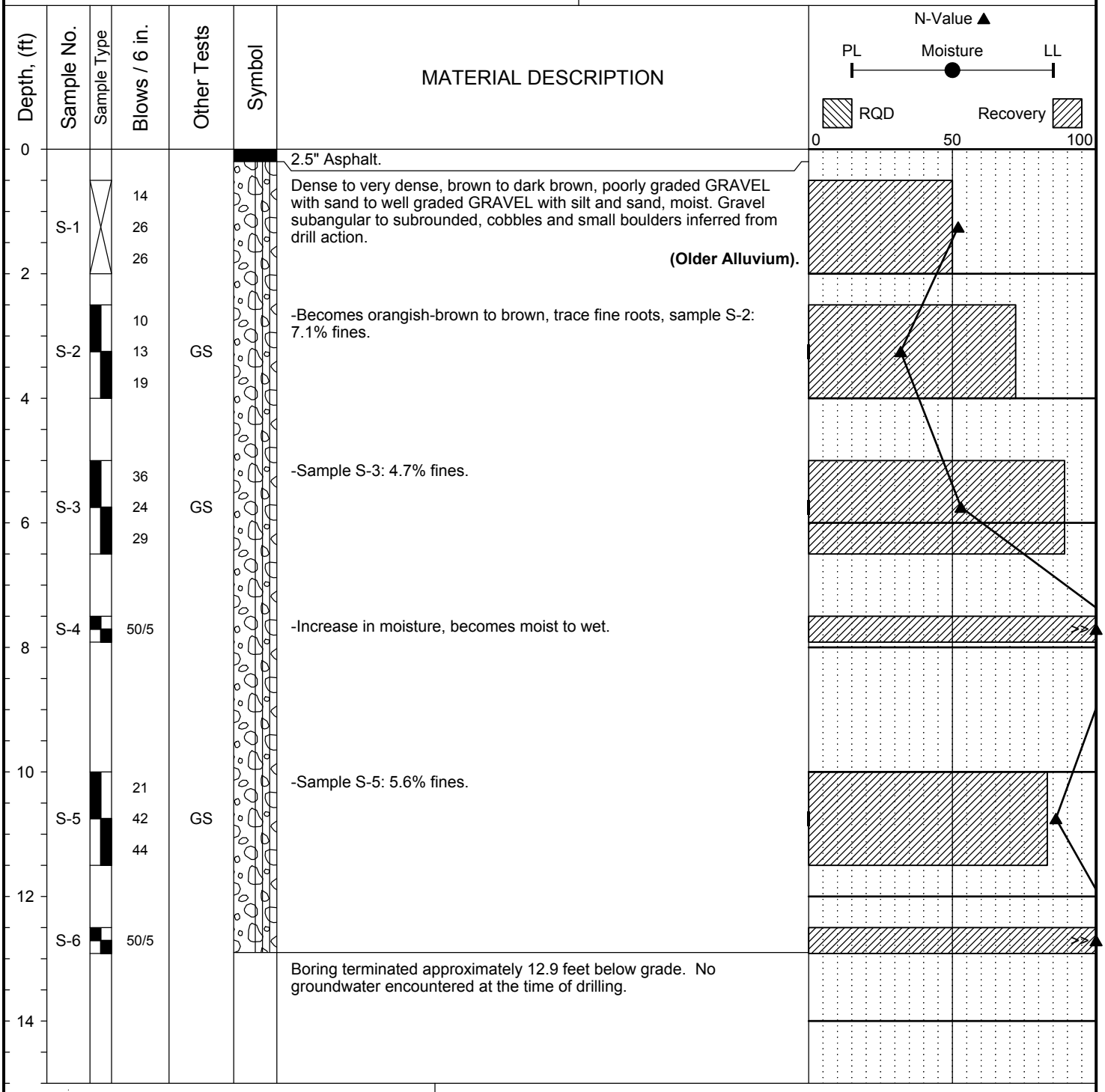
PanGEO INCORPORATED

LOG OF TEST BORING BH-4

Figure A-5

The stratification lines represent approximate boundaries. The transition may be gradual.

Project:	West Fir Street Rehabilitation	Surface Elevation:	189.0ft
Job Number:	14-167	Top of Casing Elev.:	N/A
Location:	Sequim, WA	Drilling Method:	Hollow Stem Auger
Coordinates:	Northing: , Easting:	Sampling Method:	SPT



Completion Depth:	12.9ft
Date Borehole Started:	8/21/14
Date Borehole Completed:	8/21/14
Logged By:	STS
Drilling Company:	Boretec1, Inc.

Remarks: Boring drilled with an EC-85 trailer-mounted drill rig equipped with safety hammer (cathead mechanism) for SPT.

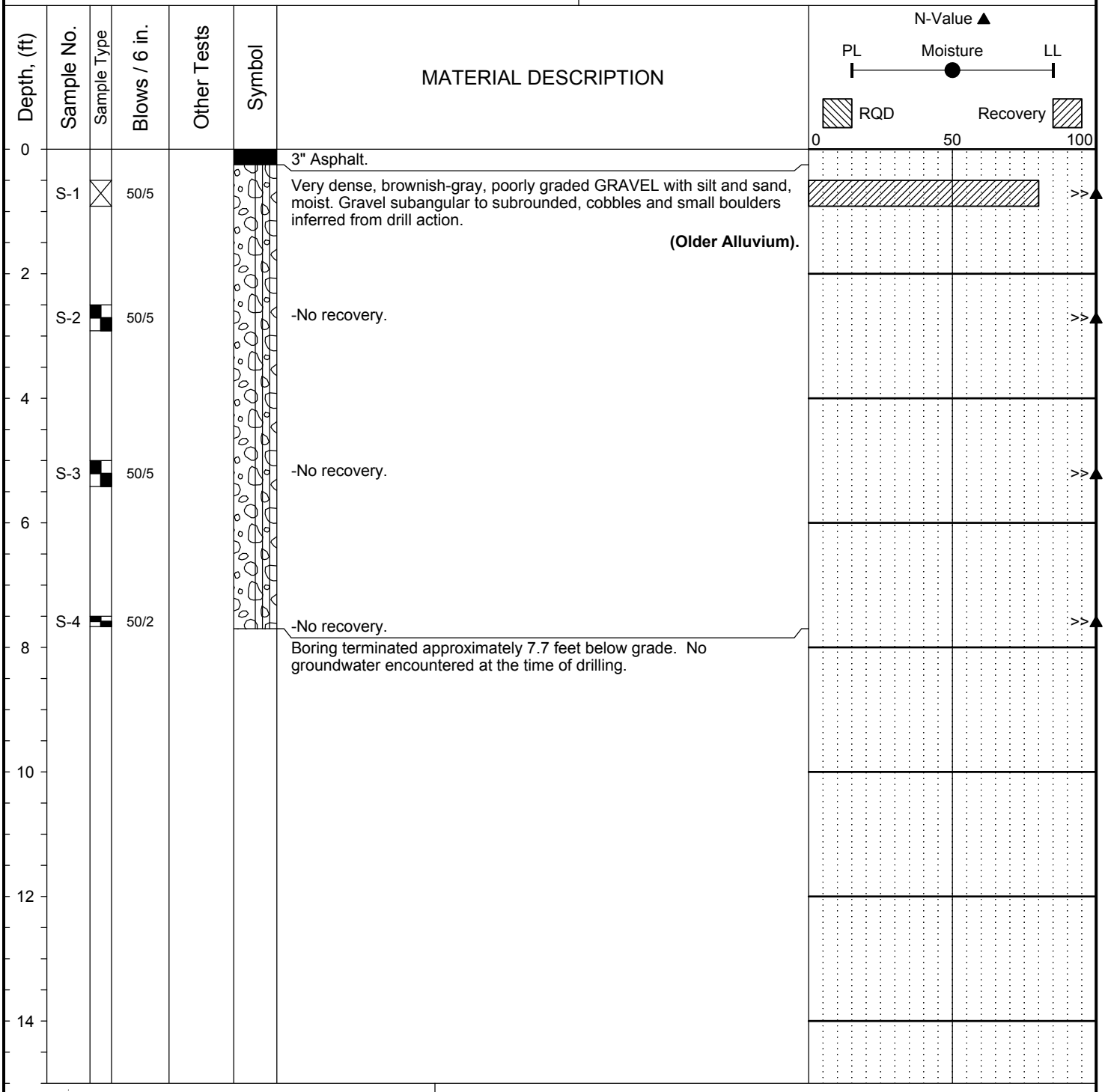
PanGEO INCORPORATED

LOG OF TEST BORING BH-5

Figure A-6

The stratification lines represent approximate boundaries. The transition may be gradual.

Project:	West Fir Street Rehabilitation	Surface Elevation:	192.0ft
Job Number:	14-167	Top of Casing Elev.:	N/A
Location:	Sequim, WA	Drilling Method:	Hollow Stem Auger
Coordinates:	Northing: , Easting:	Sampling Method:	SPT



Completion Depth:	7.7ft
Date Borehole Started:	8/21/14
Date Borehole Completed:	8/21/14
Logged By:	STS
Drilling Company:	Boretec1, Inc.

Remarks: Boring drilled with an EC-85 trailer-mounted drill rig equipped with safety hammer (cathead mechanism) for SPT.

PanGEO INCORPORATED

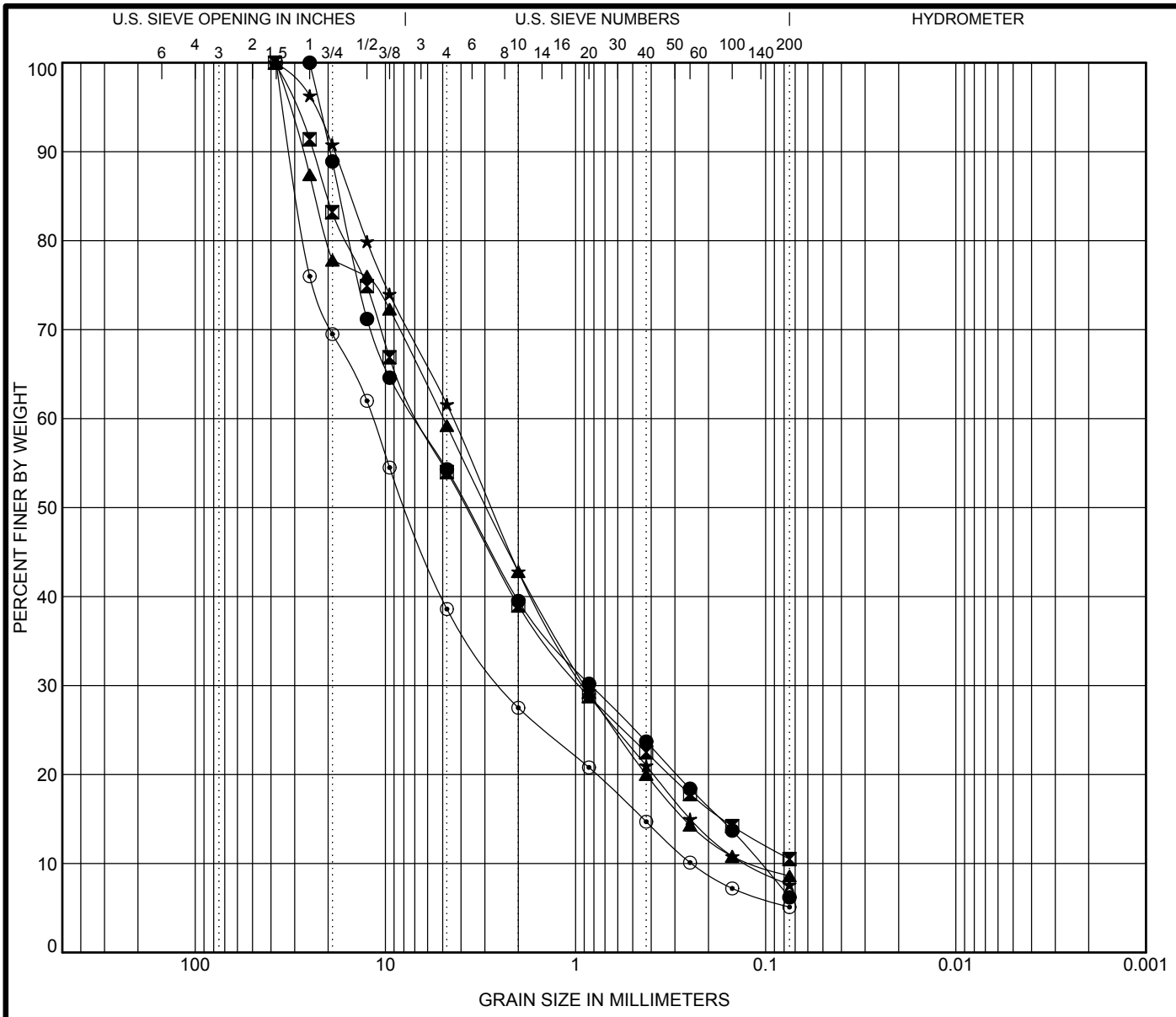
LOG OF TEST BORING BH-6

Figure A-7

The stratification lines represent approximate boundaries. The transition may be gradual.

APPENDIX B

LABORATORY TEST RESULTS



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	BH-2	@ 2.5 ft.	POORLY GRADED SAND with SILT and GRAVEL(SP-SM)	NP	NP	NP	0.93	65.42
⊠	BH-2	@ 10.0 ft.	WELL-GRADED GRAVEL with SILT and SAND(GW-GM)	NP	NP	NP	1.97	96.13
▲	BH-3	@ 5.0 ft.	WELL-GRADED SAND with SILT and GRAVEL(SW-SM)	NP	NP	NP	1.38	42.51
★	BH-3	@ 10.0 ft.	WELL-GRADED SAND with SILT and GRAVEL(SW-SM)	NP	NP	NP	1.49	34.99
⊙	BH-4	@ 2.5 ft.	WELL-GRADED GRAVEL with SILT and SAND(GW-GM)	NP	NP	NP	2.07	47.30

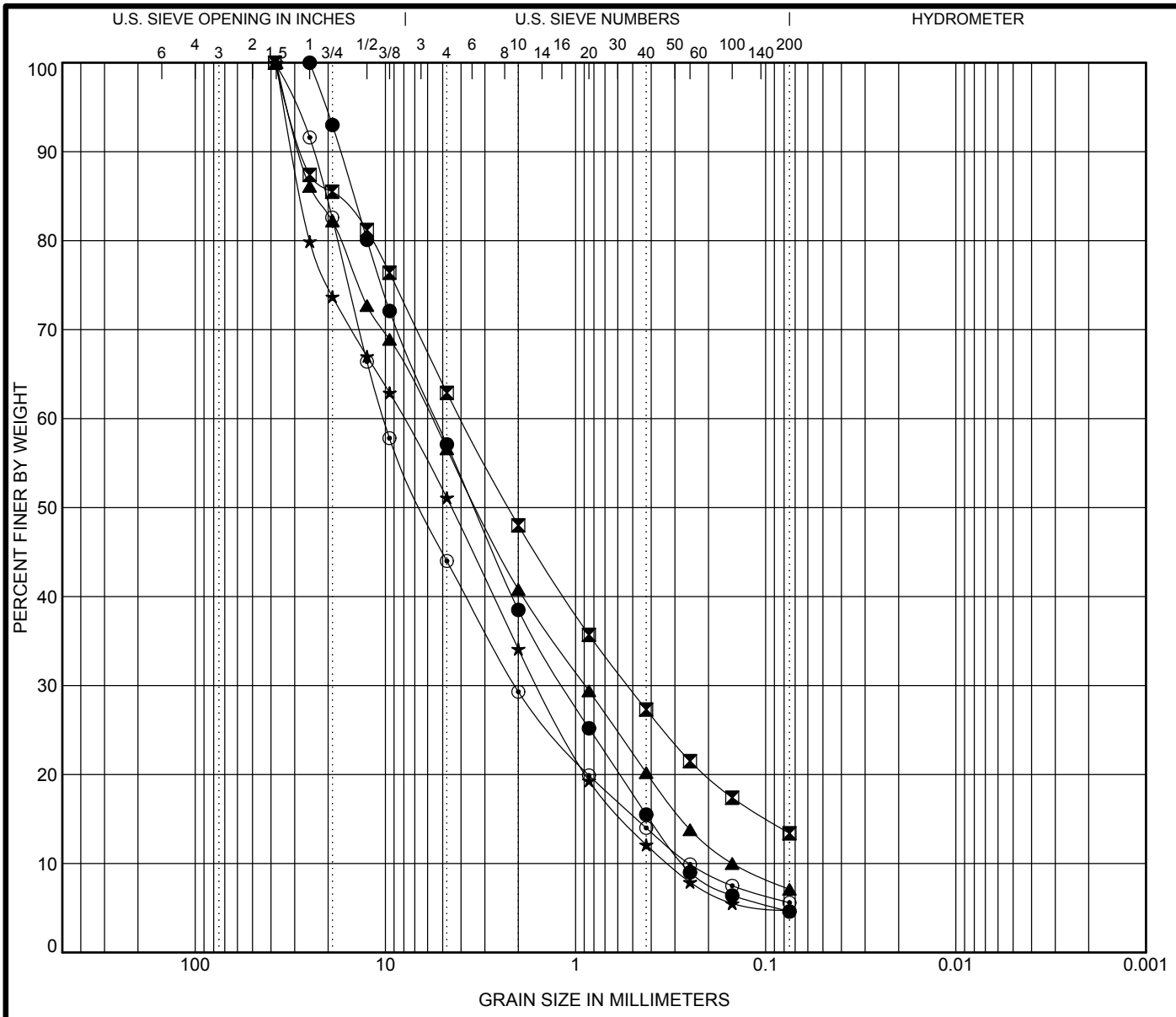
	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	BH-2	2.5	25	6.971	0.832	0.107	45.7	48.1	6.2	
⊠	BH-2	10.0	38.1	6.565	0.94		46.0	43.5	10.5	
▲	BH-3	5.0	37.5	4.955	0.894	0.117	40.8	50.6	8.6	
★	BH-3	10.0	38.1	4.413	0.91	0.126	38.4	54.0	7.6	
⊙	BH-4	2.5	37.5	11.618	2.43	0.246	61.4	33.5	5.1	

PanGEO INCORPORATED
Phone: 206.262.0370

GRAIN SIZE DISTRIBUTION

Project: West Fir Street Rehabilitation
Job Number: 14-167
Location: Sequim, WA

Figure B-1



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	BH-4	@ 5.0 ft.	POORLY GRADED SAND with GRAVEL(SP)	NP	NP	NP	0.91	20.02
⊠	BH-4	@ 10.0 ft.	SILTY SAND with GRAVEL(SM)	NP	NP	NP		
▲	BH-5	@ 2.5 ft.	POORLY GRADED SAND with SILT and GRAVEL(SP-SM)	NP	NP	NP	0.92	38.35
★	BH-5	@ 5.0 ft.	POORLY GRADED GRAVEL with SAND(GP)	NP	NP	NP	0.95	24.58
⊙	BH-5	@ 10.0 ft.	WELL-GRADED GRAVEL with SILT and SAND(GW-GM)	NP	NP	NP	1.68	40.32

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	BH-4	5.0	25	5.431	1.158	0.271	42.9	52.5	4.6	
⊠	BH-4	10.0	38.1	4.014	0.531		37.1	49.5	13.4	
▲	BH-5	2.5	37.5	5.753	0.889	0.15	43.4	49.5	7.1	
★	BH-5	5.0	37.5	8.012	1.578	0.326	48.9	46.4	4.7	
⊙	BH-5	10.0	38.1	10.211	2.084	0.253	56.0	38.4	5.6	

PanGEO INCORPORATED
Phone: 206.262.0370

GRAIN SIZE DISTRIBUTION

Project: West Fir Street Rehabilitation
Job Number: 14-167
Location: Sequim, WA

Figure B-2

SAMPLE RESULTS-CONVENTIONALS
ZC86-PanGeo

ANALYTICAL RESOURCES INCORPORATED

Matrix: Soil
Data Release Authorized:
Reported: 10/20/14

Project: W Fir Street, Sequim
Event: 14-167
Date Sampled: 09/30/14
Date Received: 10/01/14

Client ID: BH-2 S-2 2.5'/4'
ARI ID: 14-20543 ZC86A

Analyte	Date	Method	Units	RL	Sample
Total Solids	10/03/14 100314#1	SM2540G	Percent	0.01	94.57
Cation Exchange Capacity	10/14/14 101414#1	9080	meq/100 g	0.05	4.07

RL Analytical reporting limit
U Undetected at reported detection limit

SAMPLE RESULTS-CONVENTIONALS
ZC86-PanGeo

ANALYTICAL RESOURCES INCORPORATED

Matrix: Soil
Data Release Authorized:
Reported: 10/20/14

Project: W Fir Street, Sequim
Event: 14-167
Date Sampled: 09/30/14
Date Received: 10/01/14

Client ID: BH-3 S-3 5'/6'
ARI ID: 14-20544 ZC86B

Analyte	Date	Method	Units	RL	Sample
Total Solids	10/03/14 100314#1	SM2540G	Percent	0.01	96.85
Cation Exchange Capacity	10/14/14 101414#1	9080	meq/100 g	0.05	1.15

RL Analytical reporting limit
U Undetected at reported detection limit

SAMPLE RESULTS-CONVENTIONALS
ZC86-PanGeo

ANALYTICAL RESOURCES INCORPORATED

Matrix: Soil
Data Release Authorized:
Reported: 10/20/14

Project: W Fir Street, Sequim
Event: 14-167
Date Sampled: 09/30/14
Date Received: 10/01/14

Client ID: BH-4 S-2 2.5'/4'
ARI ID: 14-20545 ZC86C

Analyte	Date	Method	Units	RL	Sample
Total Solids	10/03/14 100314#1	SM2540G	Percent	0.01	94.91
Cation Exchange Capacity	10/14/14 101414#1	9080	meq/100 g	0.05	6.45

RL Analytical reporting limit
U Undetected at reported detection limit

SAMPLE RESULTS-CONVENTIONALS
ZC86-PanGeo

ANALYTICAL RESOURCES INCORPORATED

Matrix: Soil
Data Release Authorized:
Reported: 10/20/14

Project: W Fir Street, Sequim
Event: 14-167
Date Sampled: 09/30/14
Date Received: 10/01/14

Client ID: BH-4 S-3 5'/6.5'
ARI ID: 14-20546 ZC86D

Analyte	Date	Method	Units	RL	Sample
Total Solids	10/03/14 100314#1	SM2540G	Percent	0.01	95.57
Cation Exchange Capacity	10/14/14 101414#1	9080	meq/100 g	0.05	4.02

RL Analytical reporting limit
U Undetected at reported detection limit

SAMPLE RESULTS-CONVENTIONALS
ZC86-PanGeo

ANALYTICAL RESOURCES INCORPORATED

Matrix: Soil
Data Release Authorized:
Reported: 10/20/14

Project: W Fir Street, Sequim
Event: 14-167
Date Sampled: 09/30/14
Date Received: 10/01/14

Client ID: BH-5 S-2 2.5'/4'
ARI ID: 14-20547 ZC86E

Analyte	Date	Method	Units	RL	Sample
Total Solids	10/03/14 100314#1	SM2540G	Percent	0.01	98.22
Cation Exchange Capacity	10/14/14 101414#1	9080	meq/100 g	0.05	4.40

RL Analytical reporting limit
U Undetected at reported detection limit

SAMPLE RESULTS-CONVENTIONALS
ZC86-PanGeo

ANALYTICAL RESOURCES INCORPORATED

Matrix: Soil
Data Release Authorized:
Reported: 10/20/14

Project: W Fir Street, Sequim
Event: 14-167
Date Sampled: 09/30/14
Date Received: 10/01/14

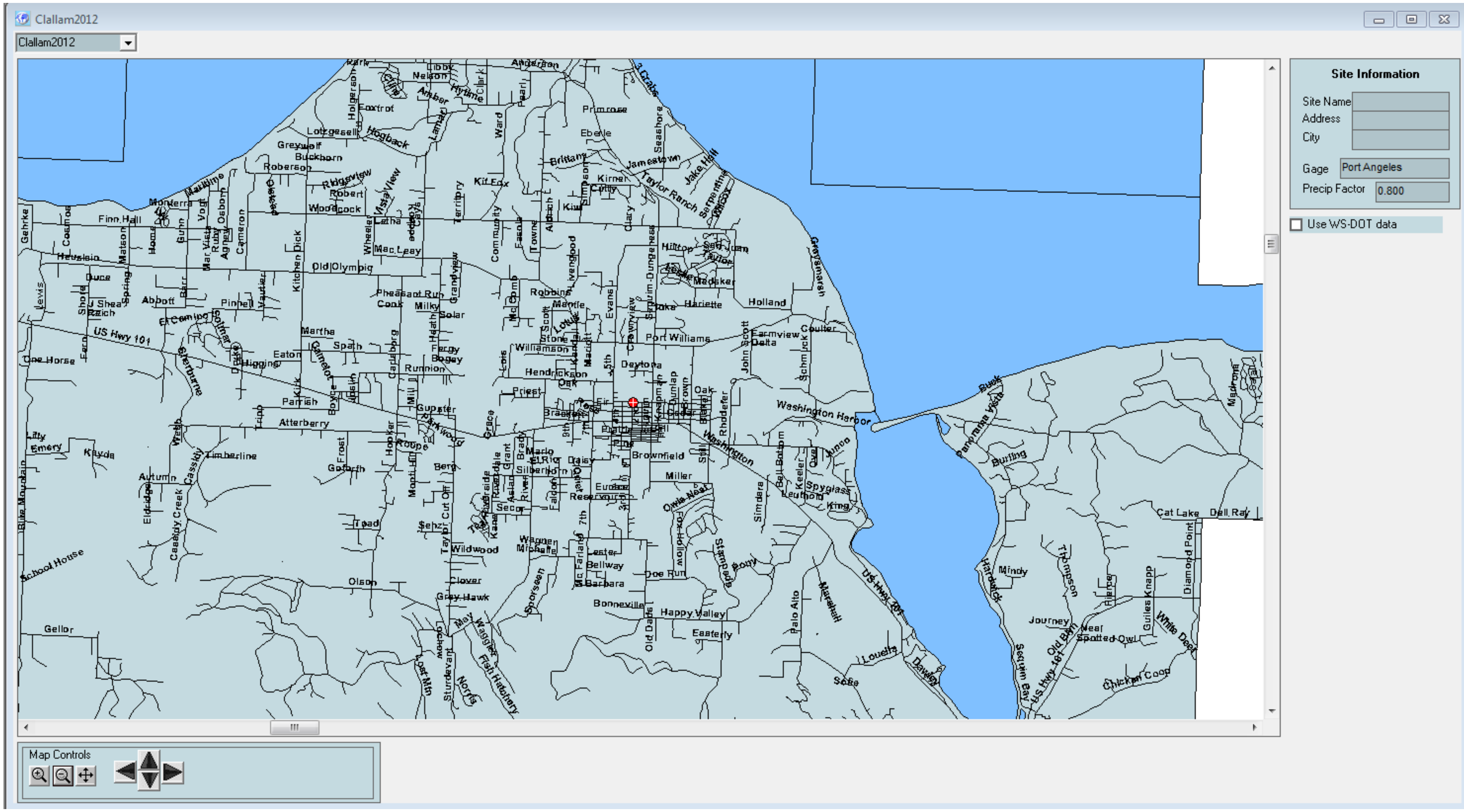
Client ID: BH-5 S-3 5'/6.5'
ARI ID: 14-20548 ZC86F

Analyte	Date	Method	Units	RL	Sample
Total Solids	10/03/14 100314#1	SM2540G	Percent	0.01	97.68
Cation Exchange Capacity	10/14/14 101414#1	9080	meq/100 g	0.05	3.53

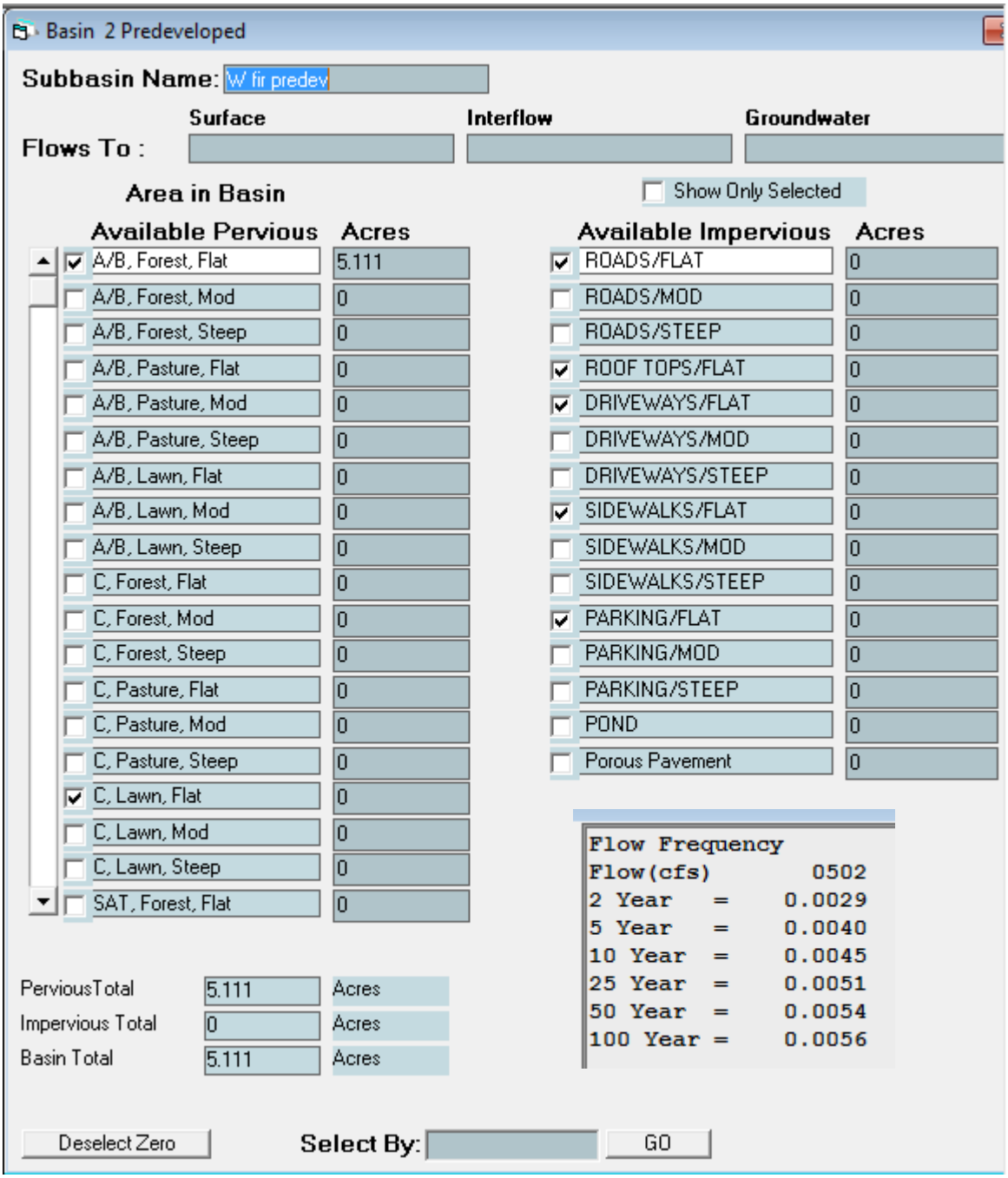
RL Analytical reporting limit
U Undetected at reported detection limit

APPENDIX B

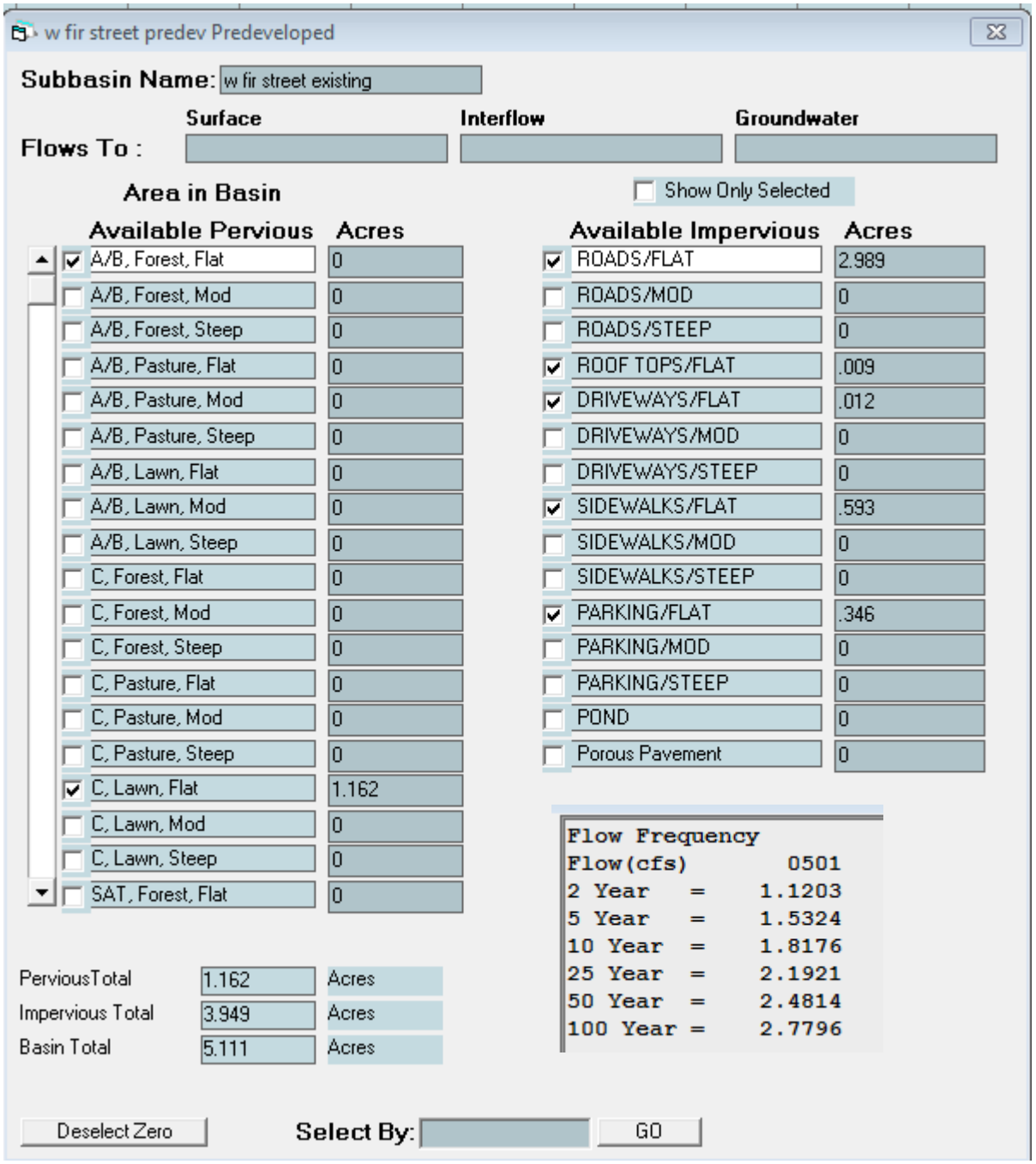
WWHM INPUTS AND OUTPUTS


Clallam2012
Clallam2012
Site Information
Site Name
Address
City
Gage
Port Angeles
Precip Factor
0.800
Use WS-DOT data
Map Controls

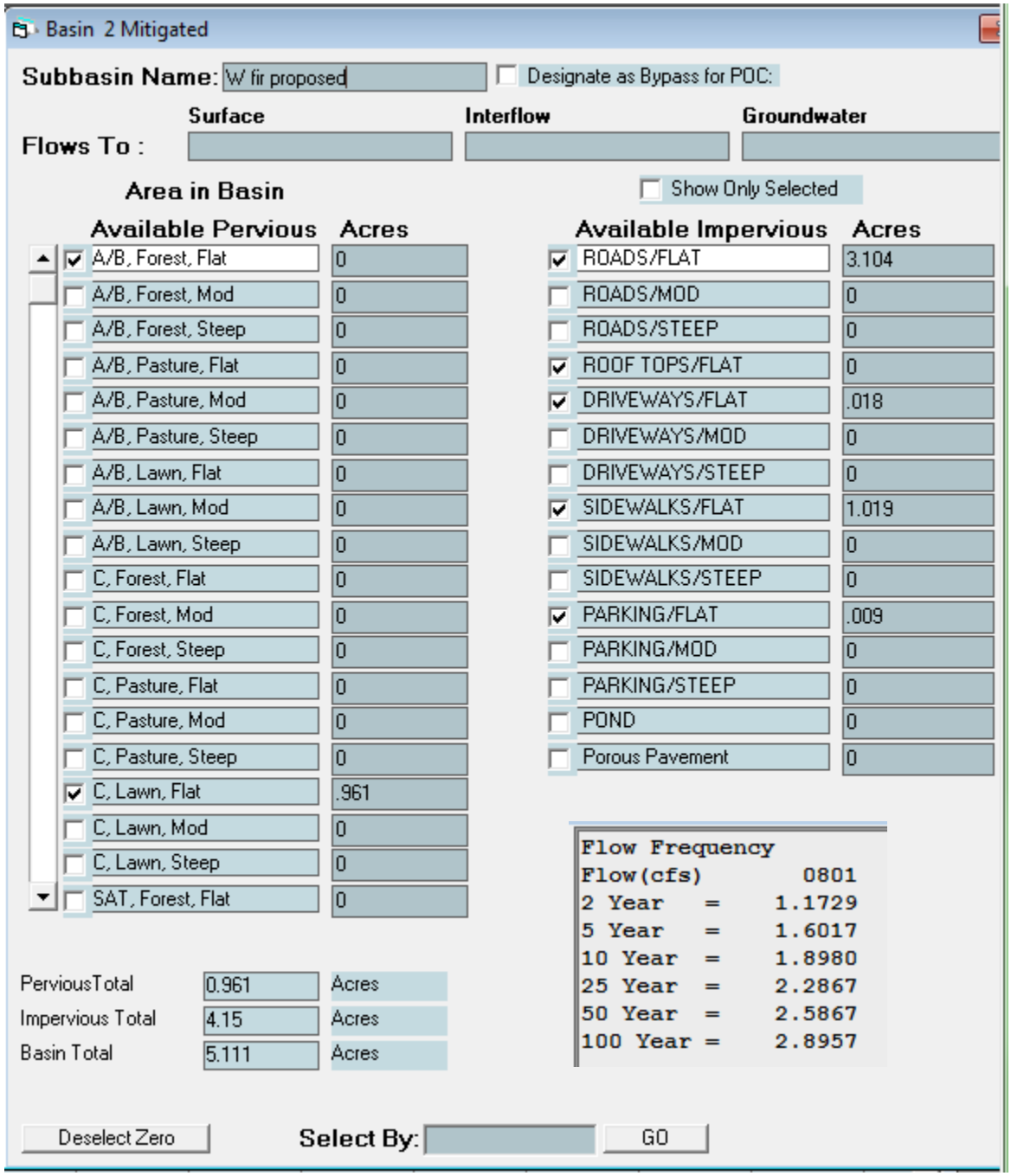
Predeveloped (forested) Condition



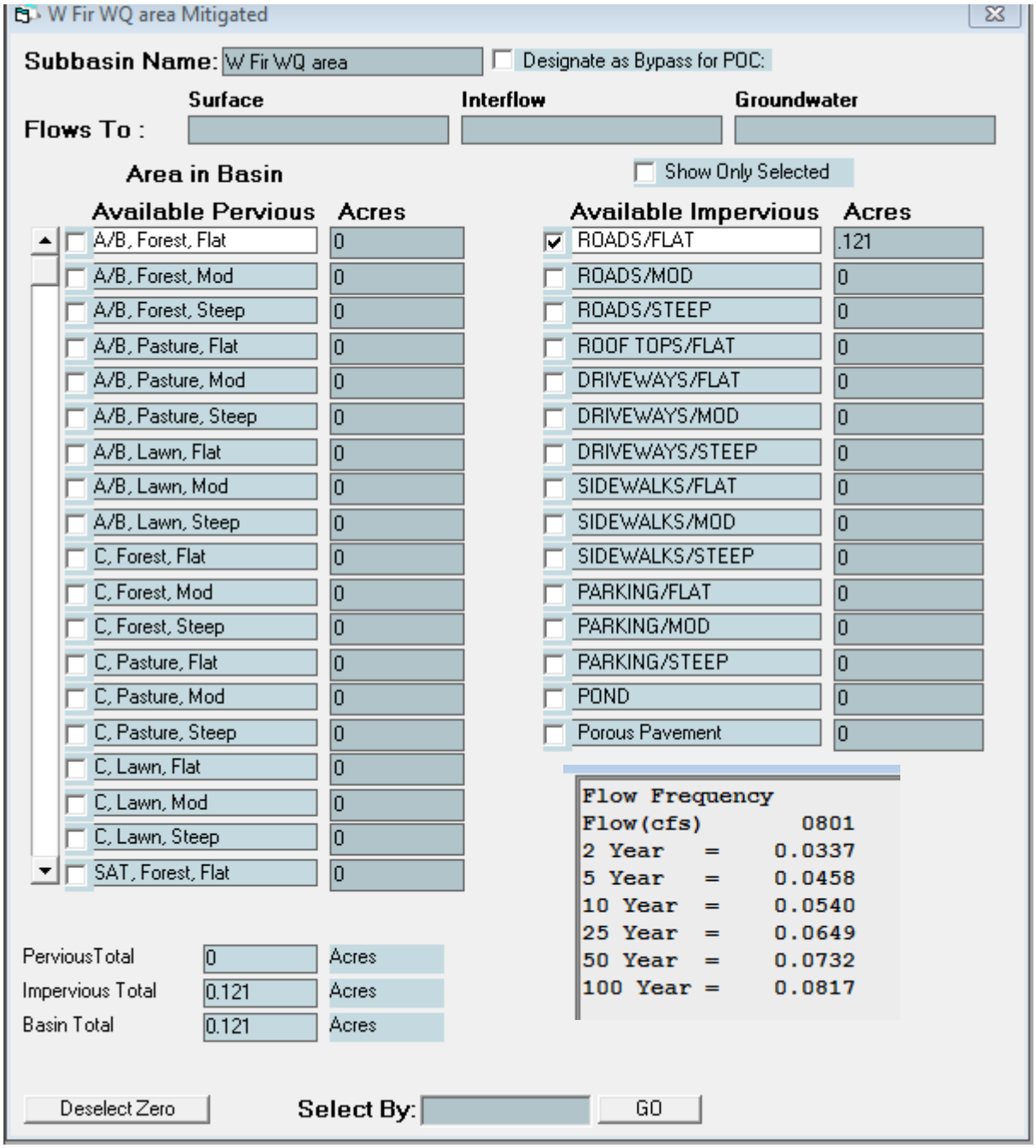
Existing Condition

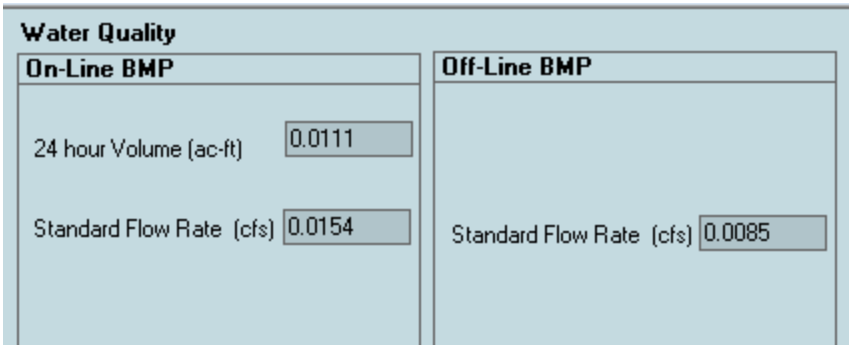


Proposed Condition (pre-infiltration) – Entire Site

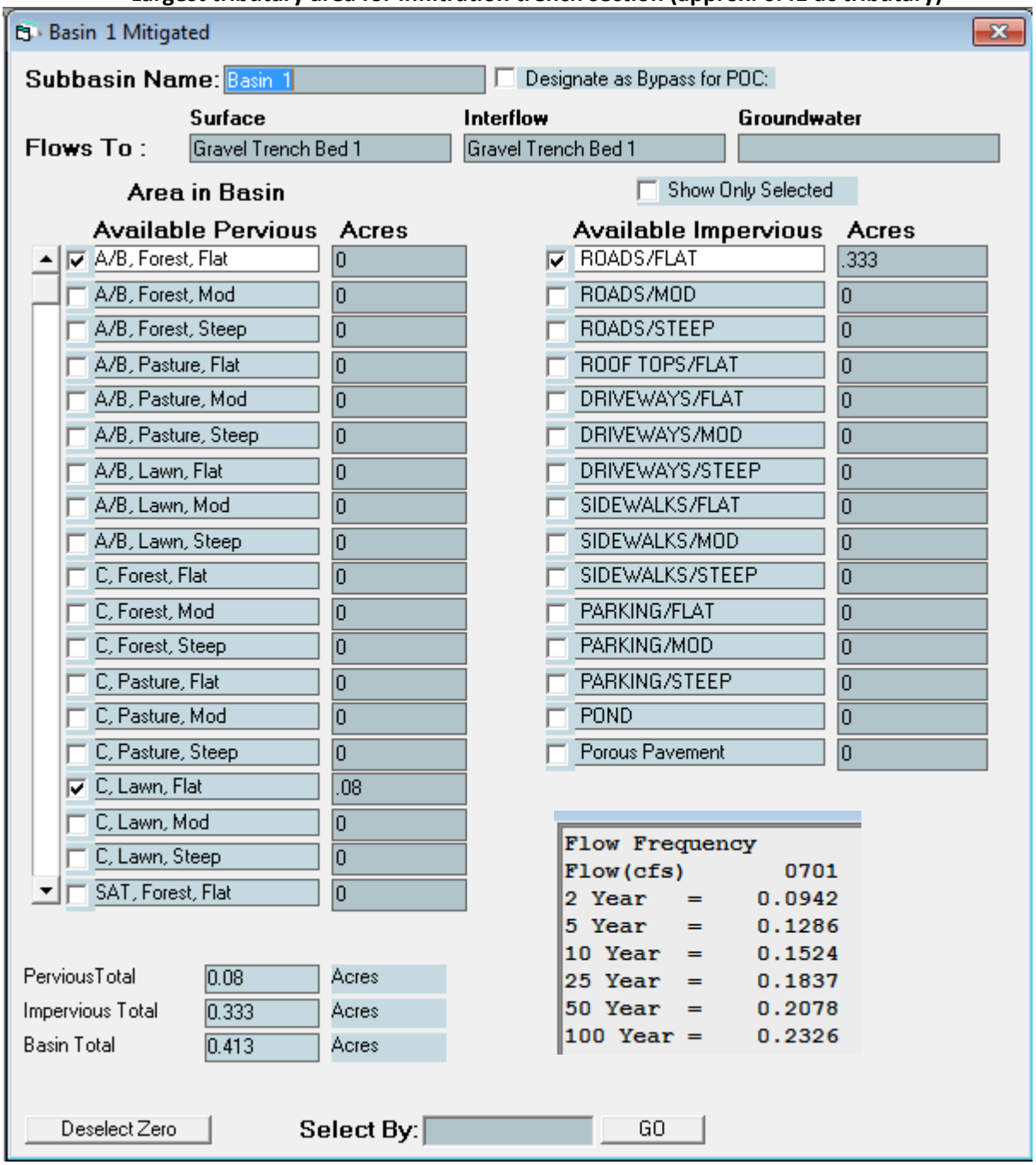


Proposed Condition Water Quality Required (0.121 ac min)

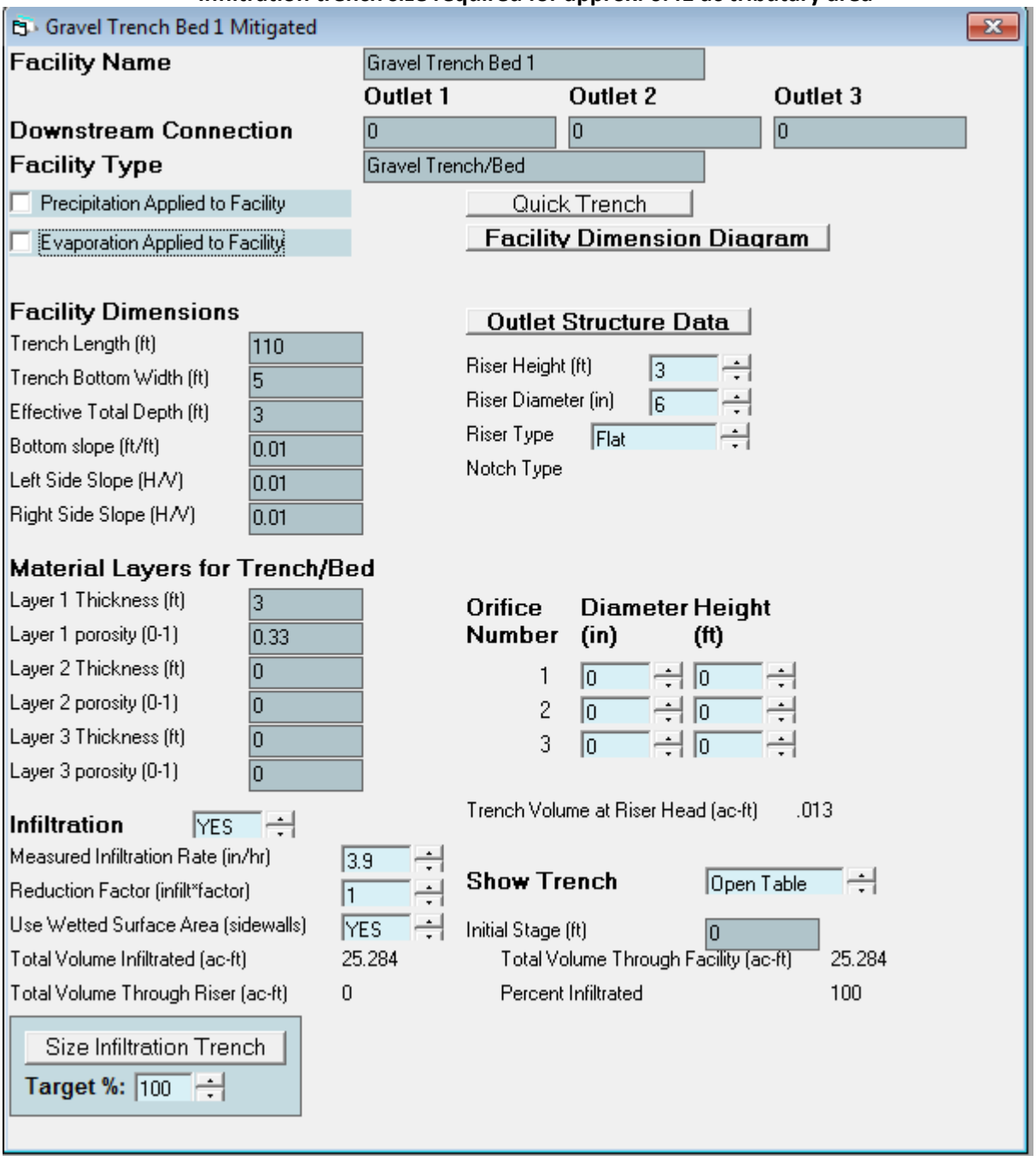




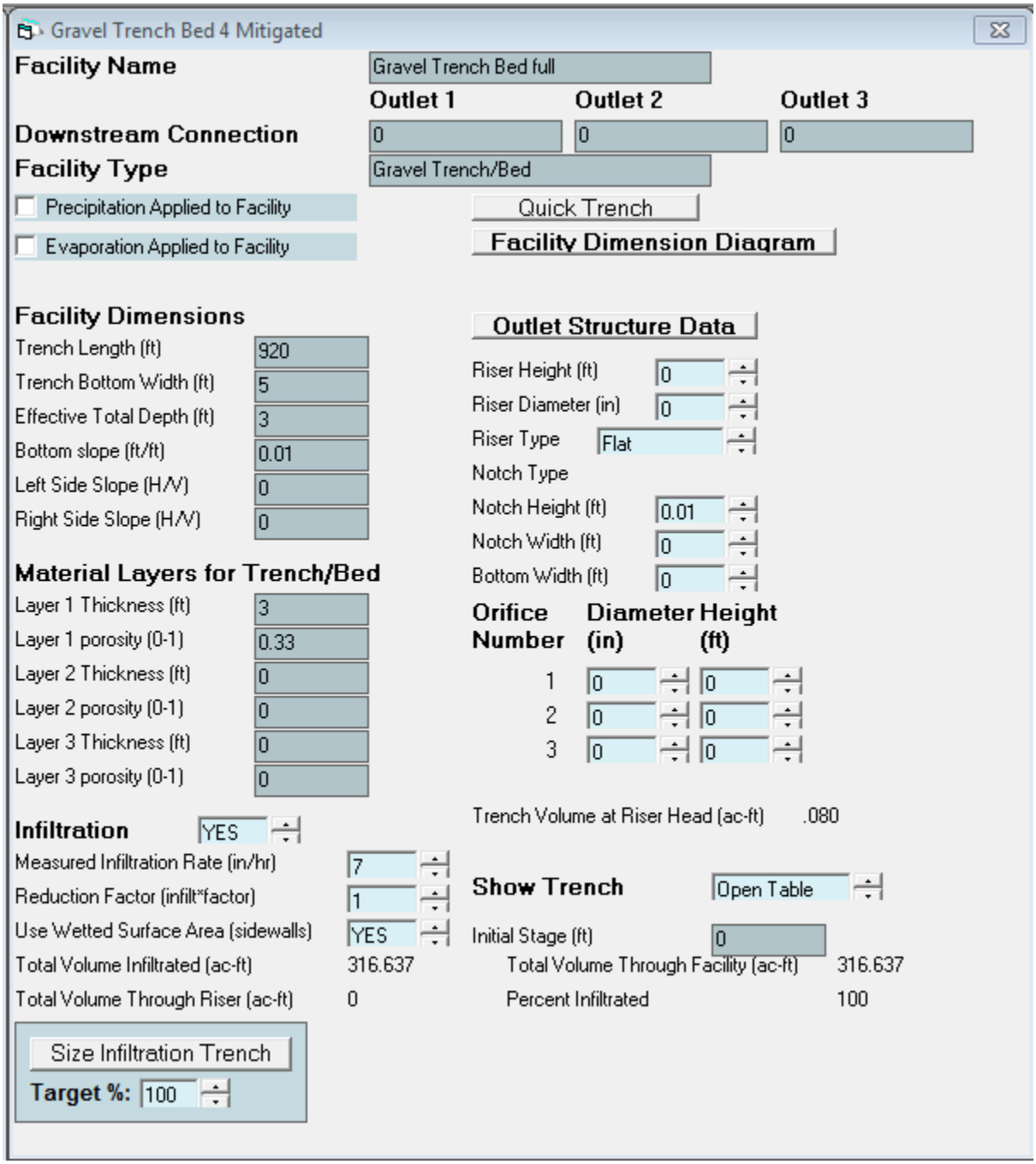
Largest tributary area for infiltration trench section (approx. 0.41 ac tributary)



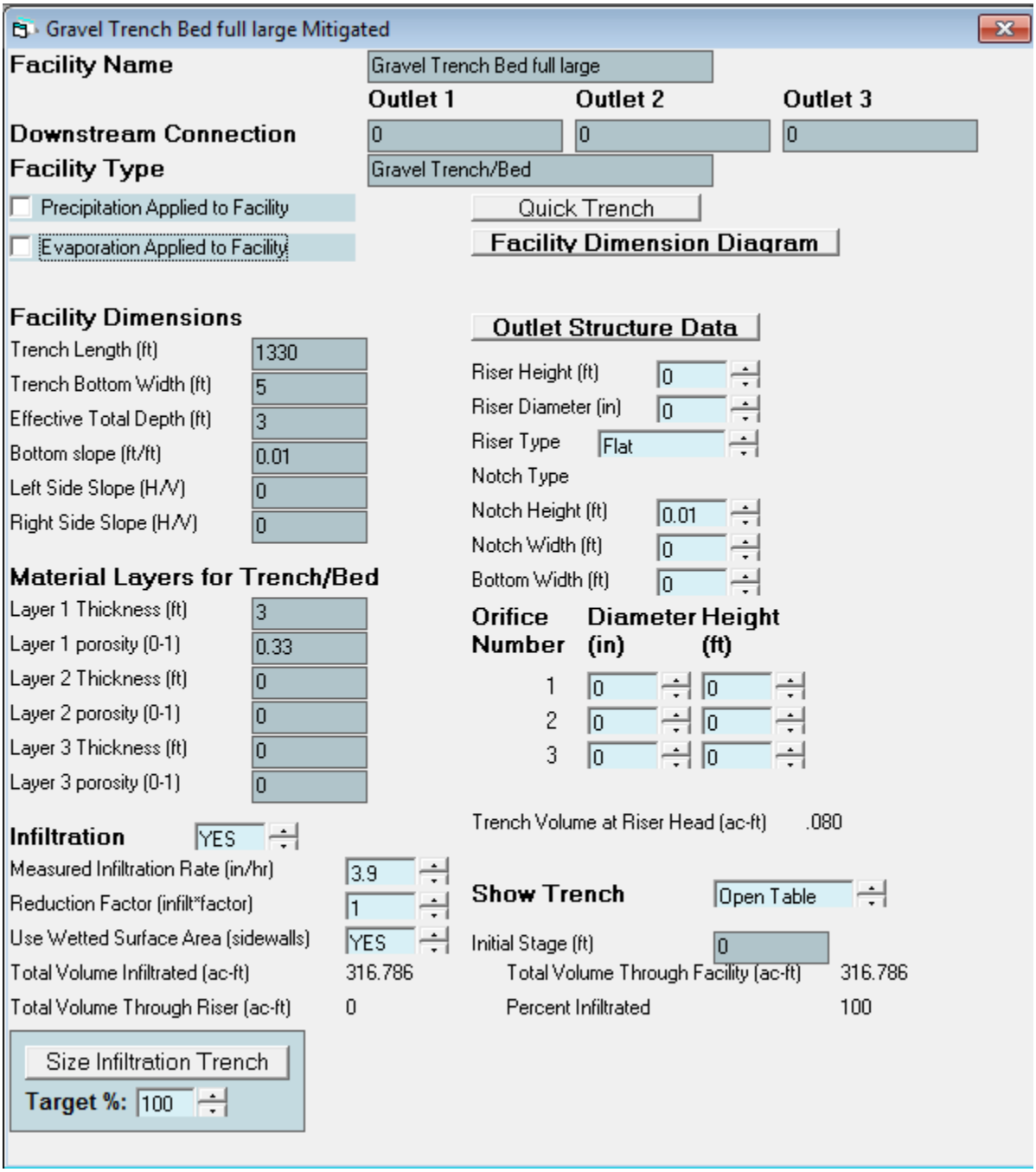
Infiltration trench size required for approx. 0.41 ac tributary area



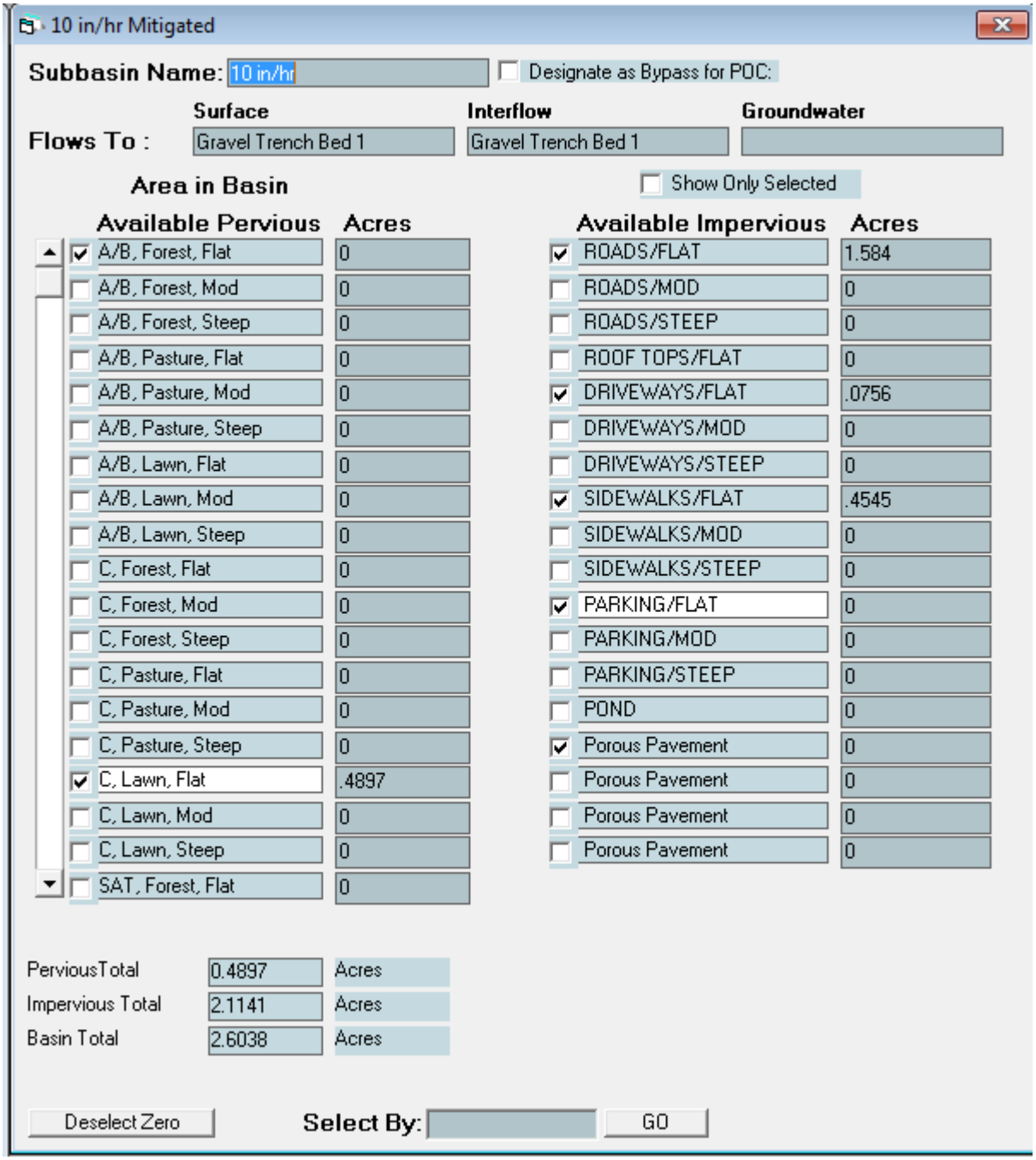
Proposed Condition Flow Control Gravel Trench – Entire Site (average 7 in/hr)

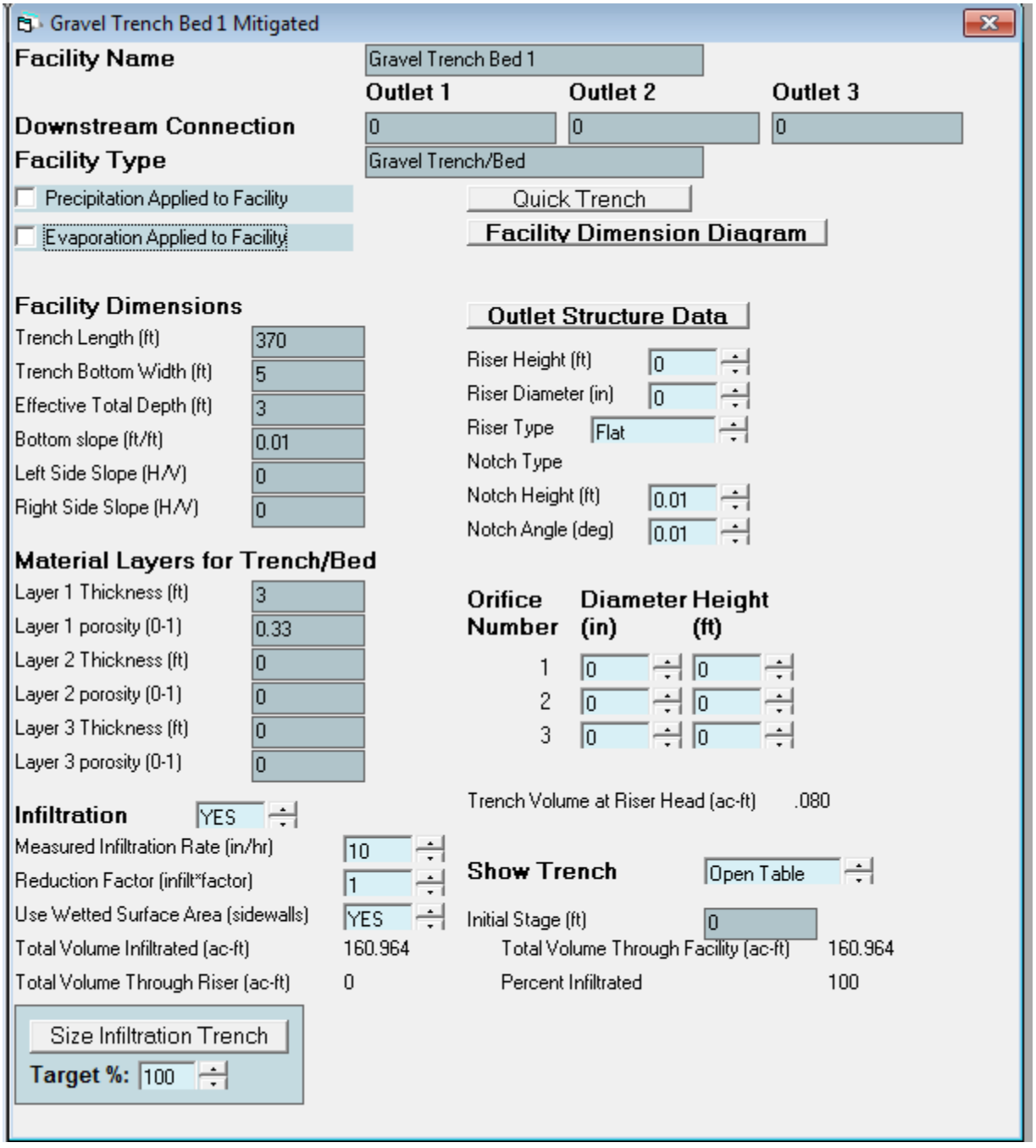


Proposed Condition Flow Control Gravel Trench – Entire Site (min 3.9 in/hr)

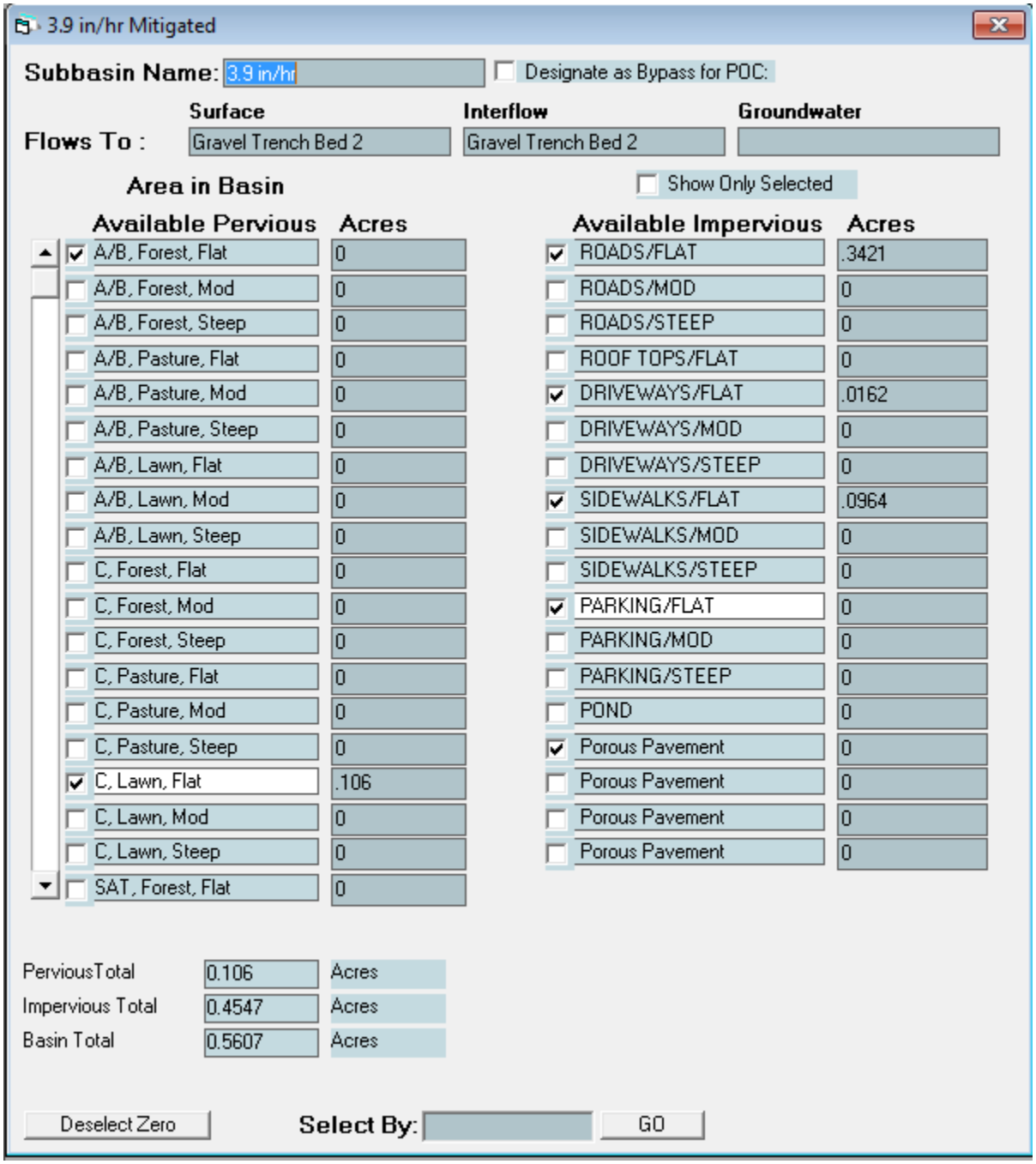


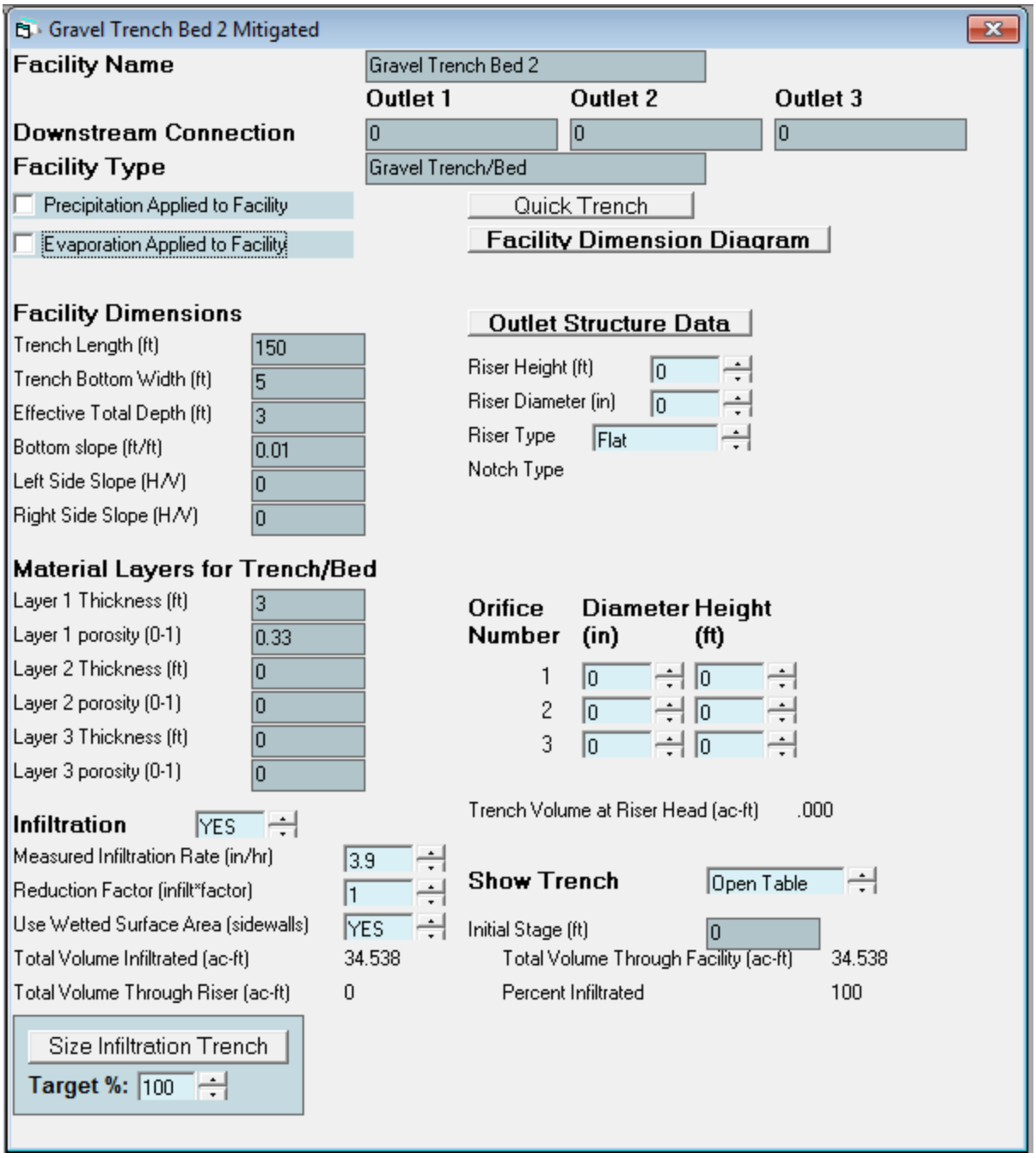
Proposed Condition Flow Control Gravel Trench – Sta 10+00 to 24+25 (10 in/hr)



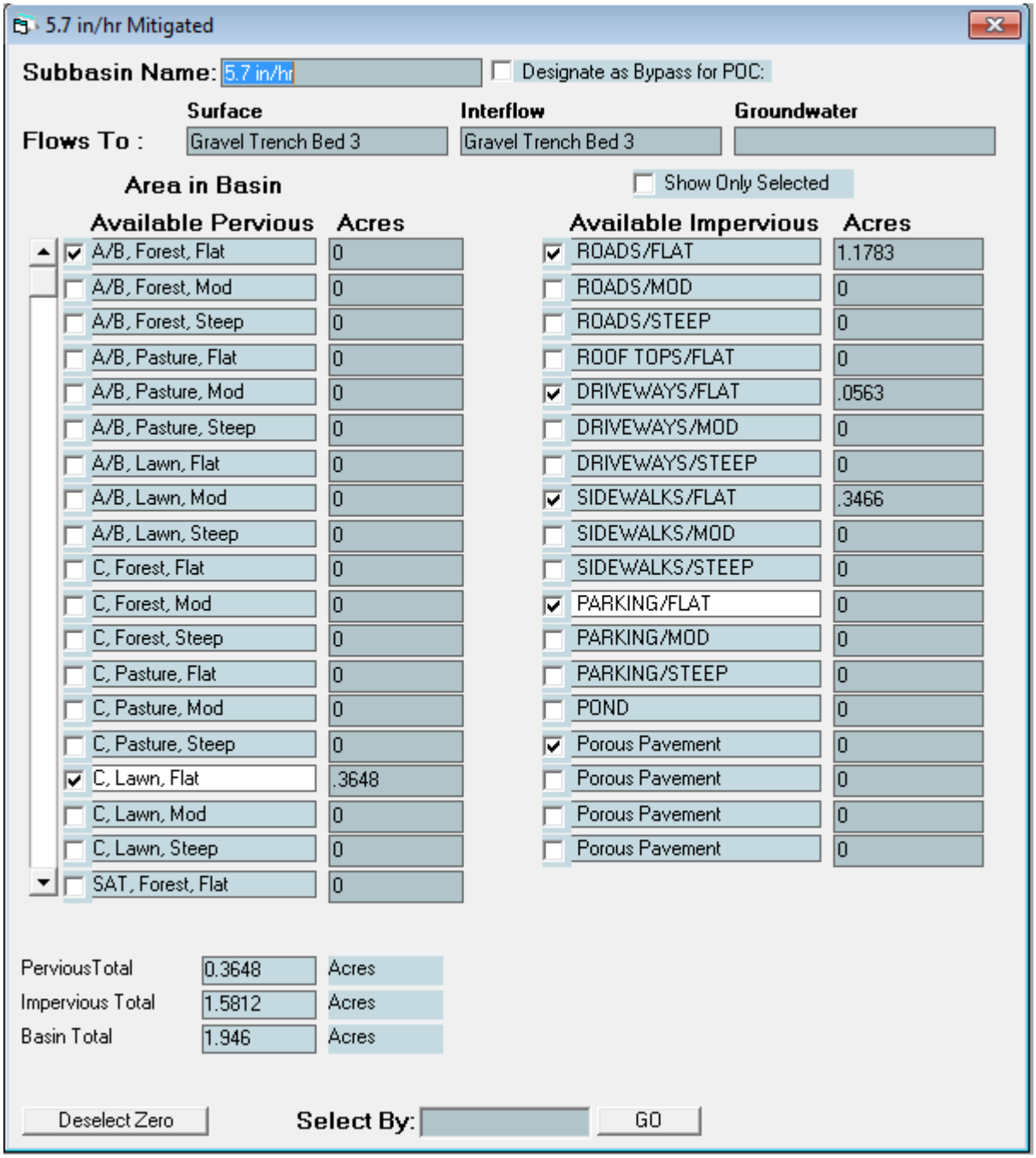

Gravel Trench Bed 1 Mitigated
Facility Name
Gravel Trench Bed 1
Outlet 1
Outlet 2
Outlet 3
Downstream Connection
0
0
0
Facility Type
Gravel Trench/Bed
Precipitation Applied to Facility
Evaporation Applied to Facility
Quick Trench
Facility Dimension Diagram
Facility Dimensions
Trench Length (ft) 370
Trench Bottom Width (ft) 5
Effective Total Depth (ft) 3
Bottom slope (ft/ft) 0.01
Left Side Slope (H/V) 0
Right Side Slope (H/V) 0
Outlet Structure Data
Riser Height (ft) 0
Riser Diameter (in) 0
Riser Type Flat
Notch Type
Notch Height (ft) 0.01
Notch Angle (deg) 0.01
Material Layers for Trench/Bed
Layer 1 Thickness (ft) 3
Layer 1 porosity (0-1) 0.33
Layer 2 Thickness (ft) 0
Layer 2 porosity (0-1) 0
Layer 3 Thickness (ft) 0
Layer 3 porosity (0-1) 0
Orifice Number
Diameter (in)
Height (ft)
1 0 0
2 0 0
3 0 0
Trench Volume at Riser Head (ac-ft) .080
Infiltration YES
Measured Infiltration Rate (in/hr) 10
Reduction Factor (infilt*factor) 1
Use Wetted Surface Area (sidewalls) YES
Total Volume Infiltrated (ac-ft) 160.964
Total Volume Through Riser (ac-ft) 0
Show Trench
Open Table
Initial Stage (ft) 0
Total Volume Through Facility (ac-ft) 160.964
Percent Infiltrated 100
Size Infiltration Trench
Target %: 100

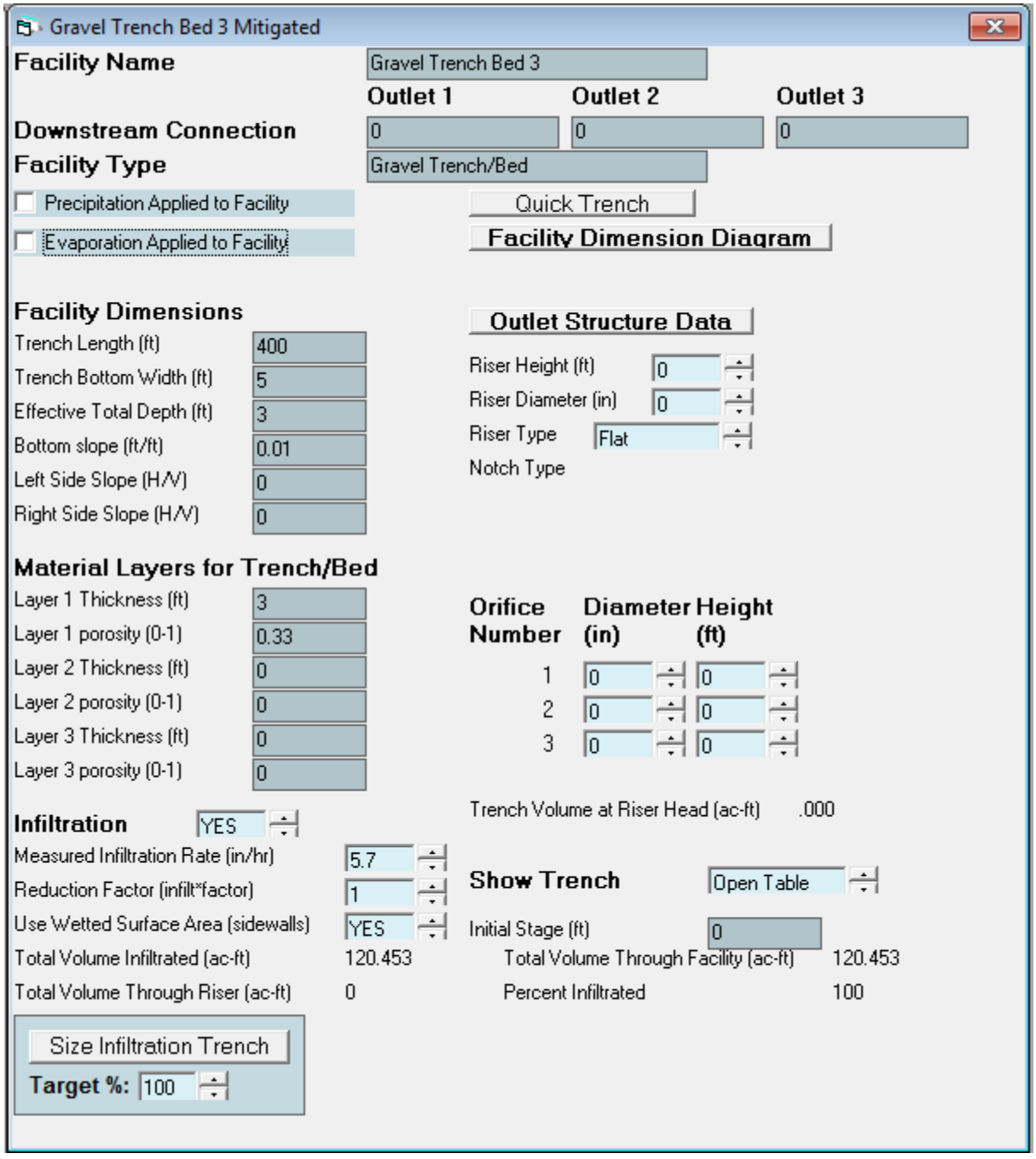
Proposed Condition Flow Control Gravel Trench – Sta 24+25 to 27+25 (3.9 in/hr)



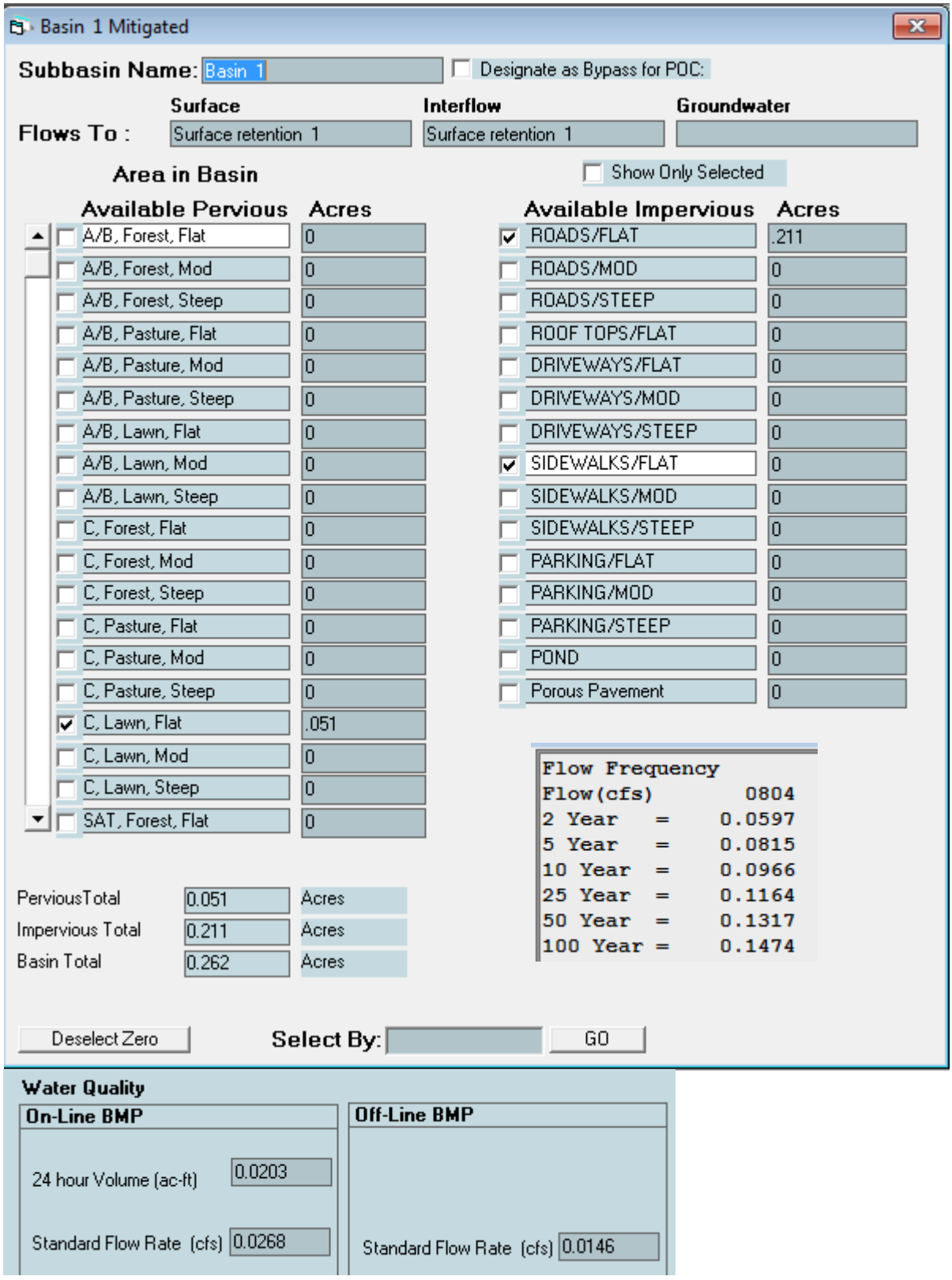

Gravel Trench Bed 2 Mitigated
Facility Name
Gravel Trench Bed 2
Outlet 1
Outlet 2
Outlet 3
Downstream Connection
0
0
0
Facility Type
Gravel Trench/Bed
Precipitation Applied to Facility
Evaporation Applied to Facility
Quick Trench
Facility Dimension Diagram
Facility Dimensions
Trench Length (ft) 150
Trench Bottom Width (ft) 5
Effective Total Depth (ft) 3
Bottom slope (ft/ft) 0.01
Left Side Slope (H/V) 0
Right Side Slope (H/V) 0
Outlet Structure Data
Riser Height (ft) 0
Riser Diameter (in) 0
Riser Type Flat
Notch Type
Material Layers for Trench/Bed
Layer 1 Thickness (ft) 3
Layer 1 porosity (0-1) 0.33
Layer 2 Thickness (ft) 0
Layer 2 porosity (0-1) 0
Layer 3 Thickness (ft) 0
Layer 3 porosity (0-1) 0
Orifice Number
Diameter (in)
Height (ft)
1 0 0
2 0 0
3 0 0
Trench Volume at Riser Head (ac-ft) .000
Infiltration YES
Measured Infiltration Rate (in/hr) 3.9
Reduction Factor (infilt*factor) 1
Use Wetted Surface Area (sidewalls) YES
Total Volume Infiltrated (ac-ft) 34.538
Total Volume Through Riser (ac-ft) 0
Show Trench Open Table
Initial Stage (ft) 0
Total Volume Through Facility (ac-ft) 34.538
Percent Infiltrated 100
Size Infiltration Trench
Target %: 100

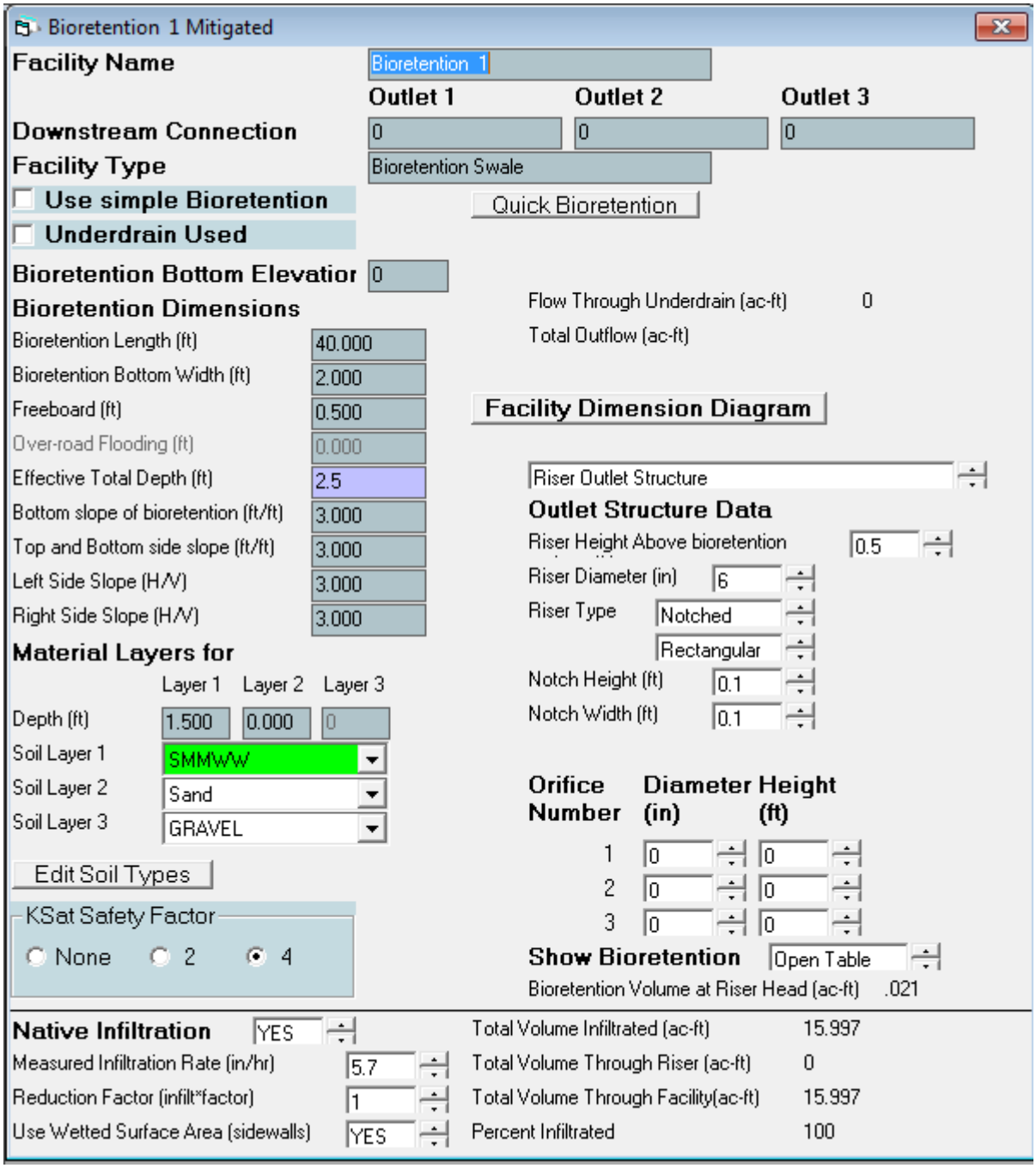
Proposed Condition Flow Control Gravel Trench – Sta 27+25 to 38+00 (5.7 in/hr)



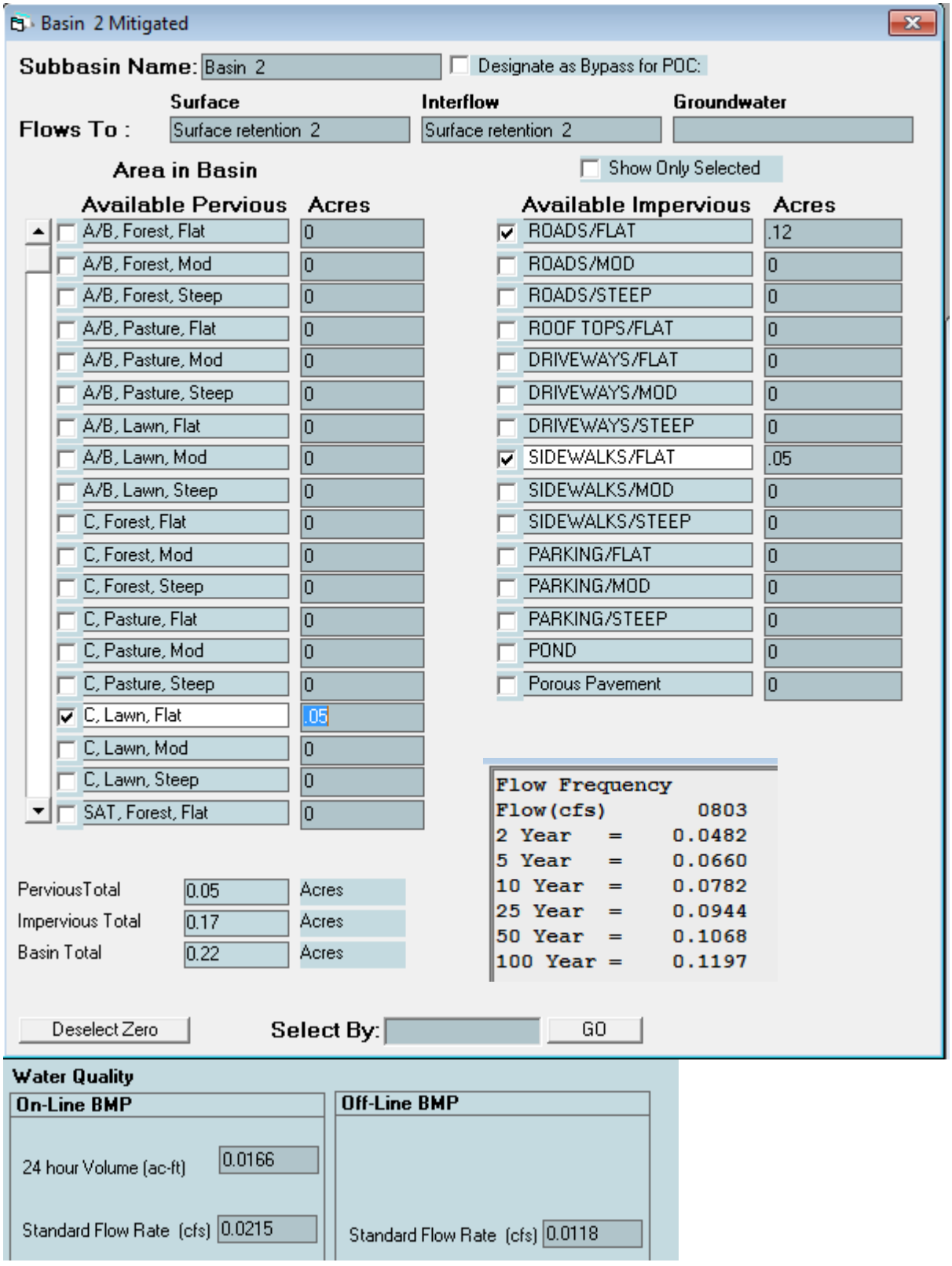

Gravel Trench Bed 3 Mitigated
Facility Name
Gravel Trench Bed 3
Outlet 1
Outlet 2
Outlet 3
Downstream Connection
0
0
0
Facility Type
Gravel Trench/Bed
Precipitation Applied to Facility
Evaporation Applied to Facility
Quick Trench
Facility Dimension Diagram
Facility Dimensions
Trench Length (ft) 400
Trench Bottom Width (ft) 5
Effective Total Depth (ft) 3
Bottom slope (ft/ft) 0.01
Left Side Slope (H/V) 0
Right Side Slope (H/V) 0
Outlet Structure Data
Riser Height (ft) 0
Riser Diameter (in) 0
Riser Type Flat
Notch Type
Material Layers for Trench/Bed
Layer 1 Thickness (ft) 3
Layer 1 porosity (0-1) 0.33
Layer 2 Thickness (ft) 0
Layer 2 porosity (0-1) 0
Layer 3 Thickness (ft) 0
Layer 3 porosity (0-1) 0
Orifice Number
Diameter (in)
Height (ft)
1 0 0
2 0 0
3 0 0
Trench Volume at Riser Head (ac-ft) .000
Infiltration YES
Measured Infiltration Rate (in/hr) 5.7
Reduction Factor (infilt*factor) 1
Use Wetted Surface Area (sidewalls) YES
Total Volume Infiltrated (ac-ft) 120.453
Total Volume Through Riser (ac-ft) 0
Show Trench
Open Table
Initial Stage (ft) 0
Total Volume Through Facility (ac-ft) 120.453
Percent Infiltrated 100
Size Infiltration Trench
Target %: 100

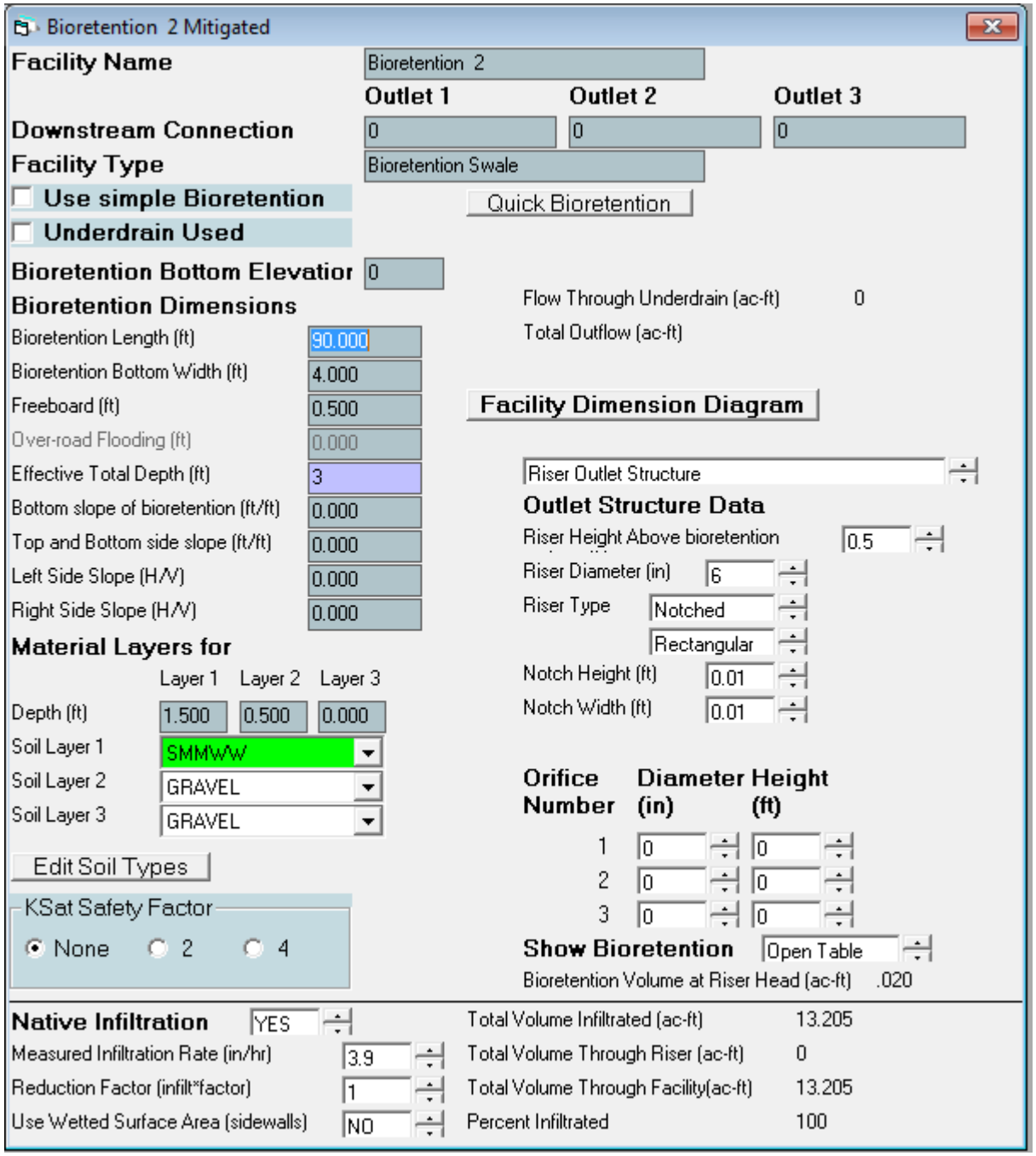
Proposed Condition Water Quality Bioretention at East End of Site




Bioretention 1 Mitigated
Facility Name
Bioretention 1
Outlet 1
Outlet 2
Outlet 3
Downstream Connection
0
0
0
Facility Type
Bioretention Swale
Use simple Bioretention
Quick Bioretention
Underdrain Used
Bioretention Bottom Elevation
0
Flow Through Underdrain (ac-ft) 0
Bioretention Dimensions
Total Outflow (ac-ft)
Bioretention Length (ft) 40.000
Bioretention Bottom Width (ft) 2.000
Freeboard (ft) 0.500
Over-road Flooding (ft) 0.000
Effective Total Depth (ft) 2.5
Bottom slope of bioretention (ft/ft) 3.000
Top and Bottom side slope (ft/ft) 3.000
Left Side Slope (H/V) 3.000
Right Side Slope (H/V) 3.000
Facility Dimension Diagram
Riser Outlet Structure
Outlet Structure Data
Riser Height Above bioretention 0.5
Riser Diameter (in) 6
Riser Type Notched
Rectangular
Notch Height (ft) 0.1
Notch Width (ft) 0.1
Material Layers for
Layer 1 Layer 2 Layer 3
Depth (ft) 1.500 0.000 0
Soil Layer 1 SMMWW
Soil Layer 2 Sand
Soil Layer 3 GRAVEL
Orifice Number
Diameter (in)
Height (ft)
1 0 0
2 0 0
3 0 0
Edit Soil Types
KSat Safety Factor
None
2
4
Show Bioretention
Open Table
Bioretention Volume at Riser Head (ac-ft) .021
Native Infiltration YES
Measured Infiltration Rate (in/hr) 5.7
Reduction Factor (infilt*factor) 1
Use Wetted Surface Area (sidewalls) YES
Total Volume Infiltrated (ac-ft) 15.997
Total Volume Through Riser (ac-ft) 0
Total Volume Through Facility(ac-ft) 15.997
Percent Infiltrated 100

Proposed Condition Water Quality Bioretention in 4-foot Planter Strip




Bioretention 2 Mitigated
Facility Name
Bioretention 2
Outlet 1
Outlet 2
Outlet 3
Downstream Connection
0
0
0
Facility Type
Bioretention Swale
Use simple Bioretention
Quick Bioretention
Underdrain Used
Bioretention Bottom Elevation
0
Bioretention Dimensions
Flow Through Underdrain (ac-ft) 0
Total Outflow (ac-ft)
Bioretention Length (ft) 90.000
Bioretention Bottom Width (ft) 4.000
Freeboard (ft) 0.500
Over-road Flooding (ft) 0.000
Effective Total Depth (ft) 3
Bottom slope of bioretention (ft/ft) 0.000
Top and Bottom side slope (ft/ft) 0.000
Left Side Slope (H/V) 0.000
Right Side Slope (H/V) 0.000
Facility Dimension Diagram
Riser Outlet Structure
Outlet Structure Data
Riser Height Above bioretention 0.5
Riser Diameter (in) 6
Riser Type Notched
Rectangular
Notch Height (ft) 0.01
Notch Width (ft) 0.01
Material Layers for
Layer 1 Layer 2 Layer 3
Depth (ft) 1.500 0.500 0.000
Soil Layer 1 SMMWW
Soil Layer 2 GRAVEL
Soil Layer 3 GRAVEL
Orifice Number
Diameter (in)
Height (ft)
1 0 0
2 0 0
3 0 0
Edit Soil Types
KSat Safety Factor
None 2 4
Show Bioretention
Open Table
Bioretention Volume at Riser Head (ac-ft) .020
Native Infiltration YES
Measured Infiltration Rate (in/hr) 3.9
Reduction Factor (infilt*factor) 1
Use Wetted Surface Area (sidewalls) NO
Total Volume Infiltrated (ac-ft) 13.205
Total Volume Through Riser (ac-ft) 0
Total Volume Through Facility(ac-ft) 13.205
Percent Infiltrated 100

APPENDIX C

CONSTRUCTION STORMWATER POLLUTION PREVENTION PLAN

Stormwater Pollution Prevention Plan

For
West Fir Street Improvements

Prepared For
Southwest Regional Office
300 Desmond Drive
Lacey, WA 98503
360-407-6300

Owner	Developer	Operator/Contractor
City of Sequim	~	TBD
152 W Cedar Street	~	~
Sequim, WA 98382	~	~

Project Site Location
W Fir St. between 5th Ave N. and Sequim Ave N., Sequim, WA

Certified Erosion and Sediment Control Lead
TBD
~

SWPPP Prepared By
Gray and Osborne, Inc.
701 Dexter Ave. N, Suite 200
Seattle, WA 98109
206-284-0860
~, ~

SWPPP Preparation Date
March 2016

Approximate Project Construction Dates
~
~

Contents

Appendix A Site plans

- Vicinity map
- Site plan with TESC measures

Appendix B Construction BMPs
Appendix C Alternative Construction BMP list
Appendix D General Permit
Appendix E Site Log and Inspection Forms

1.0 Introduction

This Stormwater Pollution Prevention Plan (SWPPP) has been prepared as part of the NPDES stormwater permit requirements for the West Fir Street Improvements construction project in Sequim, Washington. The site is located on West Fir Avenue in Sequim, WA, between N 5th Avenue and N Sequim Avenue. The existing site is an approximately 0.49 mile stretch of West Fir Avenue, including City right-of-way and some adjacent area.

The proposed development consists of a full reconstruction and realignment of approximately 0.49 miles of West Fir Street from North 5th Avenue to North Sequim Avenue. The reconstruction's typical cross-section will accommodate two 11-foot travel lanes, 5-foot bike lanes, one 8-foot parking lane on the south side, cement concrete curbs, gutters and sidewalks, and a 5-foot landscaping strip. This schedule of work also includes installation of a traffic signal at the intersection of North 5th Avenue and West Fir Street; new storm improvements, irrigation system improvements, illumination, signing, undergrounding of existing overhead utilities, and landscaping. Right-of-way will be purchased as part of this work. Additionally, the project includes the rehabilitation of the existing water and sewer utilities in West Fir Street from North 5th Avenue to North Sequim Avenue in conjunction with the rehabilitation of West Fir Street.

Construction activities will include excavation, grading, relocation of onsite services/utilities, a poured concrete sidewalk, curb and gutter, and asphalt paving. The purpose of this SWPPP is to describe the proposed construction activities and all temporary and permanent erosion and sediment control (TESC) measures, pollution prevention measures, inspection/monitoring activities, and recordkeeping that will be implemented during the proposed construction project. The objectives of the SWPPP are to:

1. Implement Best Management Practices (BMPs) to prevent erosion and sedimentation, and to identify, reduce, eliminate or prevent stormwater contamination and water pollution from construction activity.

2. Prevent violations of surface water quality, ground water quality, or sediment management standards.

3. Prevent, during the construction phase, adverse water quality impacts including impacts on beneficial uses of the receiving water by controlling peak flow rates and volumes of stormwater runoff at the Permittee's outfalls and downstream of the outfalls.

This SWPPP was prepared using the Ecology SWPPP Template downloaded from the Ecology website on November 12, 2015. This SWPPP was prepared based on the requirements set forth in the Construction Stormwater General Permit, *Stormwater Management Manual for Western Washington* (SWMMWW 2012). The report is divided into seven main sections with several appendices that include stormwater related reference materials. The topics presented in the each of the main sections are:

- Section 1 – INTRODUCTION. This section provides a summary description of the project, and the organization of the SWPPP document.

- Section 2 – SITE DESCRIPTION. This section provides a detailed description of the existing site conditions, proposed construction activities, and calculated stormwater flow rates for existing conditions and post–construction conditions.

- Section 3 – CONSTRUCTION BMPs. This section provides a detailed description of the BMPs to be implemented based on the 12 required elements of the SWPPP (SWMMWW 2012).

- Section 4 – CONSTRUCTION PHASING AND BMP IMPLEMENTATION. This section provides a description of the timing of the BMP implementation in relation to the project schedule.

- Section 5 – POLLUTION PREVENTION TEAM. This section identifies the appropriate contact names (emergency and non-emergency), monitoring personnel, and the onsite temporary erosion and sedimentation control inspector

- Section 6 – INSPECTION AND MONITORING. This section provides a description of the inspection and monitoring requirements such as the parameters of concern to be monitored, sample locations, sample frequencies, and sampling methods for all stormwater discharge locations from the site.

- Section 7 – RECORDKEEPING. This section describes the requirements for documentation of the BMP implementation, site inspections, monitoring results, and changes to the implementation of certain BMPs due to site factors experienced during construction.

Supporting documentation and standard forms are provided in the following Appendices:

Appendix A – Site plans
Appendix B – Construction BMPs
Appendix C – Alternative Construction BMP list
Appendix D – General Permit
Appendix E – Site Log and Inspection Forms

2.0 Site Description

2.1 Existing Conditions

The proposed site is located in the center of Sequim, WA, along W Fir Street between N 5th Avenue and N Sequim Avenue. A site vicinity map and coordinates are provided in Appendix A. The site is approximately 5.1 acres in size and encompasses mainly City right-of-way, though some adjacent property is included in the project site. The topography of the site and surrounding properties gently slopes to the northwest. Surficial soils consist of 1 foot of possible fill underlain by older alluvium ranging from poorly graded gravel with sand and silt content to poorly graded sand with silt and gravel content. The site is well drained and groundwater in the area lies approximately 36 to 39 feet below the surface.

The project site currently has no stormwater conveyance or stormwater flow control or treatment facilities. Water sheet flows off of the site to the east, following the roadway grade. Runoff from the road frequently floods across adjacent properties to the north of the roadway. In the natural condition, flows from the project area might discharge to Gierin Creek, which is located within the City, approximately 2,000 feet down slope of the project site to the northeast. The Creek very rarely carries any flow within the City limits, and is mostly fed by irrigation in summer and stormwater runoff in winter. Gierin Creek flows from the City limits approximately 2.25 miles to the northeast to discharge into Puget Sound. Gierin Creek is not listed on Ecology's 303d water quality list for impaired water bodies, so no additional TMDL requirements apply.

There are no critical areas on the site such as high erosion risk areas, wetlands, streams, or steep slopes (potential landslide area).

2.2 Proposed Construction Activities

The proposed development includes a full reconstruction and realignment of approximately 0.49 miles of West Fir Street, and the rehabilitation of the existing water and sewer utilities in the roadway, from North 5th Avenue to North Sequim Avenue. Stormwater facilities onsite will include curb inlets and infiltration trenches beneath the sidewalks to provide flow control via infiltration, as well as bioretention basins to treat stormwater.

Construction activities will include site preparation, TESC installation, removal of the existing roadway, excavation for the new and relocated utilities, poured concrete sidewalk and curb and gutter, concrete tilt-up building construction, site-wide grading, and asphalt paving. The schedule and phasing of BMPs during construction is provided in Section 4.0.

The following summarizes details regarding site areas:

- Total site area: 5.11 acres
- Percent impervious area before construction: 75 %
- Percent impervious area after construction: 81 %
- Disturbed area during construction: 5.11 acres
- Disturbed area that is characterized as impervious (i.e., access roads, staging, parking): 3.95 acres
- 2-year stormwater runoff peak flow prior to construction (existing): 1.1203 cfs
- 10-year stormwater runoff peak flow prior to construction (existing): 1.8176 cfs
- 2-year stormwater runoff peak flow during construction: 1.1729 cfs
- 10-year stormwater runoff peak flow during construction: 1.8980 cfs
- 2-year stormwater runoff peak flow after construction: 0 cfs
- 10-year stormwater runoff peak flow after construction: 0 cfs

3.0 Construction Stormwater BMPs

3.1 The 12 BMP Elements

3.1.1 Element #1 – Mark Clearing Limits

To protect adjacent properties and to reduce the area of soil exposed to construction, the limits of construction will be clearly marked before land-disturbing activities begin. Trees that are to be preserved, as well as all sensitive areas and their buffers, shall be clearly delineated, both in the field and on the plans. In general, natural vegetation and native topsoil shall be retained in an undisturbed state to the maximum extent possible. The BMPs relevant to marking the clearing limits that will be applied for this project include:

No BMPs to be implemented

No BMPs are to be implemented for this element of the SWPPP as minimal clearing is planned to take place for the installation of the roadway improvements. The roadway will be reconstructed and its width will be slightly expanded, including the addition of sidewalk and parking areas. The construction limits are defined by the existing roadway and the existing shoulder area, most of which is contained within City right-of-way, and most of which is already impervious. The shoulder areas that are not currently impervious are fully cleared and either dirt or grass covered.

3.1.2 Element #2 – Establish Construction Access

Construction access or activities occurring on unpaved areas shall be minimized, yet where necessary, access points shall be stabilized to minimize the tracking of sediment onto public roads, and wheel washing, street sweeping, and street cleaning shall be employed to prevent sediment from entering state waters. All wash wastewater shall be controlled on site. The specific BMPs related to establishing construction access that will be used on this project include:

Stabilized Construction Entrance (BMP C105)

Construction Road/Parking Area Stabilization (BMP C107)

Construction access will be limited to paved areas adjacent to the project limits. The project site may be accessed from the east or west along Fir Street, or from the south along N 4th Ave, N 3rd Ave, and N 2nd Ave. These are all paved, public rights-of-way.

Alternate construction access BMPs are included in Appendix C as a quick reference tool for the onsite inspector in the event the BMP(s) listed above are deemed ineffective or inappropriate during construction to satisfy the requirements set forth in the General NPDES Permit (Appendix D). To avoid potential erosion and sediment control issues that may cause a violation(s) of the NPDES Construction Stormwater permit (as provided in Appendix D), the Certified Erosion and Sediment Control Lead will promptly initiate the implementation of one or more of the alternative BMPs listed in Appendix C after the first sign that existing BMPs are ineffective or failing.

3.1.3 Element #3 – Control Flow Rates

In order to protect the properties and waterways downstream of the project site, stormwater discharges from the site will be controlled. The specific BMPs for flow control that shall be used on this project include:

Silt Fence (BMP C233)

Straw Bale Barrier (BMP C230)

The project will increase runoff volumes, as the roadway prism will be slightly expanded, and an addition (approximately 0.547 acres) of impervious sidewalk and parking area will be installed. The project area has no existing stormwater conveyance system or controls. Runoff sheet flows from the site generally to the east and north, following the gradually sloped topography of the site.

Alternate flow control BMPs are included in Appendix C as a quick reference tool for the onsite inspector in the event the BMP(s) listed above are deemed ineffective or inappropriate during construction to satisfy the requirements set forth in the General NPDES Permit (Appendix D). To avoid potential erosion and sediment control issues that may cause a violation(s) of the NPDES Construction Stormwater permit (as provided in Appendix D), the Certified Erosion and Sediment Control Lead will promptly initiate the implementation of one or more of the alternative BMPs listed in Appendix C after the first sign that existing BMPs are ineffective or failing.

The project site is located west of the Cascade Mountain Crest. As such, the project must comply with Minimum Requirement 7 (Ecology 2012).

In general, discharge rates of stormwater from the site will be controlled where increases in impervious area or soil compaction during construction could lead to downstream erosion, or where necessary to meet local agency stormwater discharge requirements (e.g. discharge to combined sewer systems).

3.1.4 Element #4 – Install Sediment Controls

All stormwater runoff from disturbed areas shall pass through an appropriate sediment removal BMP before leaving the construction site or prior to being discharged to an infiltration facility. The specific BMPs to be used for controlling sediment on this project include:

Straw Bale Barrier (BMP C230)

Silt Fence (BMP C233)

Straw Wattles (BMP C235)

Storm Drain Inlet Protection (BMP C220)

Sediment from the project site will be managed using straw bales and silt fencing where necessary, as well as wattles and inlet protection to protect catch basins. The project site is very gently sloped to the east, so these BMPs will be implemented throughout the site and at the downslope areas to catch sediment before it sheet flows off site. Additionally, catch basin inserts will be installed in the existing catch basin inlets to limit the amount of sediment washed downstream.

Alternate sediment control BMPs are included in Appendix C as a quick reference tool for the onsite inspector in the event the BMP(s) listed above are deemed ineffective or inappropriate during construction to satisfy the requirements set forth in the General NPDES Permit (Appendix D). To avoid potential erosion and sediment control issues that may cause a violation(s) of the NPDES Construction Stormwater permit (as provided in Appendix D), the Certified Erosion and Sediment Control Lead will promptly initiate the implementation of one or more of the alternative BMPs listed in Appendix C after the first sign that existing BMPs are ineffective or failing.

In addition, sediment will be removed from paved areas in and adjacent to construction work areas manually or using mechanical sweepers, as needed, to minimize tracking of sediments on vehicle tires away from the site and to minimize washoff of sediments from adjacent streets in runoff.

Whenever possible, sediment laden water shall be discharged into onsite, relatively level, vegetated areas.

In some cases, sediment discharge in concentrated runoff can be controlled using permanent stormwater BMPs (e.g., infiltration swales, ponds, trenches). Sediment loads can limit the effectiveness of some permanent stormwater BMPs, such as those used for infiltration or biofiltration. When permanent stormwater BMPs will be used to control sediment discharge during construction, the structure will be protected from excessive sedimentation with adequate erosion and sediment control BMPs. Any accumulated sediment shall be removed after construction is complete and the permanent stormwater BMP will be restabilized with vegetation per applicable design requirements once the remainder of the site has been stabilized.

3.1.5 Element #5 – Stabilize Soils

Exposed and unworked soils shall be stabilized with the application of effective BMPs to prevent erosion throughout the life of the project. The specific BMPs for soil stabilization that shall be used on this project include:

Temporary and Permanent Seeding (BMP C120)

Plastic Covering (BMP C123)

Dust Control (BMP C140)

The project includes only minimal disturbance of impervious areas. The existing roadway will be paved after reconstruction. New sidewalk and paved parking areas will be installed alongside the road; part of this new impervious surface will be replacing existing grassed or soil areas, and some will be replacing gravel shoulders or paved driveways. Where grassed areas have been disturbed during construction, planting and seeding will be used at the end of the project for restoration. All stockpiled materials will be appropriately covered during construction to limit the potential for runoff contamination.

Alternate soil stabilization BMPs are included in Appendix C as a quick reference tool for the onsite inspector in the event the BMP(s) listed above are deemed ineffective or inappropriate during construction to satisfy the requirements set forth in the General NPDES Permit (Appendix D). To avoid potential erosion and sediment control issues that may cause a violation(s) of the NPDES Construction Stormwater permit (as provided in Appendix D), the Certified Erosion and Sediment Control Lead will promptly initiate the implementation of one or more of the alternative BMPs listed in Appendix C after the first sign that existing BMPs are ineffective or failing.

The project site is located west of the Cascade Mountain Crest. As such, no soils shall remain exposed and unworked for more than 7 days during the dry season (May 1 to September 30) and 2 days during the wet season (October 1 to April 30). Regardless of the time of year, all soils shall be stabilized at the end of the shift before a holiday or weekend if needed based on weather forecasts.

In general, cut and fill slopes will be stabilized as soon as possible and soil stockpiles will be temporarily covered with plastic sheeting. All stockpiled soils shall be stabilized from erosion, protected with sediment trapping measures, and where possible, be located away from storm drain inlets, waterways, and drainage channels.

3.1.6 Element #6 – Protect Slopes

All cut and fill slopes will be designed, constructed, and protected in a manner than minimizes erosion. The following specific BMPs will be used to protect slopes for this project:

No BMPs to be implemented

As mentioned, the site slopes are very gradual within the project vicinity – less than 5% and generally around 1% to 2% – from southwest to northeast. During construction of the repaved roadway, minimal grading is planned to take place. If slopes are disturbed, the alternate BMPs included in the Appendix of this SWPPP will be used to prevent sediment-laden runoff from being swept downstream. Disturbance to slopes is expected to be minimal during the project.

Alternate slope protection BMPs are included in Appendix C as a quick reference tool for the onsite inspector in the event the BMP(s) listed above are deemed ineffective or inappropriate during construction to satisfy the requirements set forth in the General NPDES Permit (Appendix

D). To avoid potential erosion and sediment control issues that may cause a violation(s) of the NPDES Construction Stormwater permit (as provided in Appendix D), the Certified Erosion and Sediment Control Lead will promptly initiate the implementation of one or more of the alternative BMPs listed in Appendix C after the first sign that existing BMPs are ineffective or failing.

3.1.7 Element #7 – Protect Drain Inlets

All storm drain inlets and culverts made operable during construction shall be protected to prevent unfiltered or untreated water from entering the drainage conveyance system. However, the first priority is to keep all access roads clean of sediment and keep street wash water separate from entering storm drains until treatment can be provided. Storm Drain Inlet Protection (BMP C220) will be implemented for all drainage inlets and culverts that could potentially be impacted by sediment-laden runoff on and near the project site. The following inlet protection measures will be applied on this project:

Drop Inlet Protection

Catch Basin Filters

There is no existing stormwater system within the project limits. New curb inlets and bioretention facilities will be installed during the project. The inlets to these facilities will be protected from sediment inflow during construction. Catch basin inserts will be used on all catch basins to reduce the risk of sediment laden runoff discharging to the new drainage facilities before the construction site is stabilized.
If the BMP options listed above are deemed ineffective or inappropriate during construction to satisfy the requirements set forth in the General NPDES Permit (Appendix D), or if no BMPs are listed above but deemed necessary during construction, the Certified Erosion and Sediment Control Lead shall implement one or more of the alternative BMP inlet protection options listed in Appendix C.

3.1.8 Element #8 – Stabilize Channels and Outlets

Where site runoff is to be conveyed in channels, or discharged to a stream or some other natural drainage point, efforts will be taken to prevent downstream erosion. The specific BMPs for channel and outlet stabilization that shall be used on this project include:

No BMPs to be implemented

No channels, streams, or other natural drainage points exist on the project site – drainage currently sheet flows along the roadway and across adjacent properties. The nearest surface water is Gierin Creek, located approximately 0.5 miles downslope to the northeast, This waterway is dry a majority of the time and flows from the project site are not anticipated to affect the waterway since the City does not have a stormwater system that would convey flow from the

project area to Gierin Creek. Because of the shallow slopes in the project area and the developed properties adjacent to the roadway, it is not anticipated that downstream erosion will be of concern.

Alternate channel and outlet stabilization BMPs are included in Appendix C as a quick reference tool for the onsite inspector in the event the BMP(s) listed above are deemed ineffective or inappropriate during construction to satisfy the requirements set forth in the General NPDES Permit (Appendix D). To avoid potential erosion and sediment control issues that may cause a violation(s) of the NPDES Construction Stormwater permit (as provided in Appendix D), the Certified Erosion and Sediment Control Lead will promptly initiate the implementation of one or more of the alternative BMPs listed in Appendix C after the first sign that existing BMPs are ineffective or failing.

The project site is located west of the Cascade Mountain Crest. As such, all temporary on-site conveyance channels shall be designed, constructed, and stabilized to prevent erosion from the expected peak 10 minute velocity of flow from a Type 1A, 10-year, 24-hour recurrence interval storm for the developed condition. Alternatively, the 10-year, 1-hour peak flow rate indicated by an approved continuous runoff simulation model, increased by a factor of 1.6, shall be used. Stabilization, including armoring material, adequate to prevent erosion of outlets, adjacent streambanks, slopes, and downstream reaches shall be provided at the outlets of all conveyance systems.

3.1.9 Element #9 – Control Pollutants

All pollutants, including waste materials and demolition debris, that occur onsite shall be handled and disposed of in a manner that does not cause contamination of stormwater. Good housekeeping and preventative measures will be taken to ensure that the site will be kept clean, well-organized, and free of debris. If required, BMPs to be implemented to control specific sources of pollutants are discussed below.

Vehicles, construction equipment, and/or petroleum product storage/dispensing:

- All vehicles, equipment, and petroleum product storage/dispensing areas will be inspected regularly to detect any leaks or spills, and to identify maintenance needs to prevent leaks or spills.
- On-site fueling tanks and petroleum product storage containers shall include secondary containment.
- Spill prevention measures, such as drip pans, will be used when conducting maintenance and repair of vehicles or equipment.
- In order to perform emergency repairs on site, temporary plastic will be placed beneath and, if raining, over the vehicle.

- Contaminated surfaces shall be cleaned immediately following any discharge or spill incident.

Demolition:

- Process water and slurry resulting from sawcutting and surfacing operations will be prevented from entering the waters of the State by implementing Sawcutting and Surfacing Pollution Prevention measures (BMP C152).

Concrete and grout:

- Process water and slurry resulting from concrete work will be prevented from entering the waters of the State by implementing Concrete Handling measures (BMP C151).

The facility is transportation-related and therefore not subject to the Federal requirements of the Spill Prevention, Control, and Countermeasure (SPCC) Plan under the Clean Water Act (CWA). If applicable, the Contractor shall prepare an SPCC Plan according to the Washington State Department of Transportation (WSDOT) Requirements (see the *WSDOT Standard Specifications for Road, Bridge, and Municipal Construction* 2014).

3.1.10 Element #10 – Control Dewatering

Based on information regarding the depth to groundwater included in the Geotechnical Report trench dewatering will most likely not be required for this construction project.

3.1.11 Element #11 – Maintain BMPs

All temporary and permanent erosion and sediment control BMPs shall be maintained and repaired as needed to assure continued performance of their intended function. Maintenance and repair shall be conducted in accordance with each particular BMPs specifications (attached). Visual monitoring of the BMPs will be conducted at least once every calendar week and within 24 hours of any stormwater or non-stormwater discharge from the site. If the site becomes inactive, and is temporarily stabilized, the inspection frequency will be reduced to once every month.

All temporary erosion and sediment control BMPs shall be removed within 30 days after the final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment shall be removed or stabilized on site. Disturbed soil resulting from removal of BMPs or vegetation shall be permanently stabilized.

3.1.12 Element #12 – Manage the Project

Erosion and sediment control BMPs for this project have been designed based on the following principles:

- Design the project to fit the existing topography, soils, and drainage patterns.
- Emphasize erosion control rather than sediment control.
- Minimize the extent and duration of the area exposed.
- Keep runoff velocities low.
- Retain sediment on site.
- Thoroughly monitor site and maintain all ESC measures.
- Schedule major earthwork during the dry season.

In addition, project management will incorporate the key components listed below:

As this project site is located west of the Cascade Mountain Crest, the project will be managed according to the following key project components:

Phasing of Construction

- The construction project is being phased to the extent practicable in order to prevent soil erosion, and, to the maximum extent possible, the transport of sediment from the site during construction.
- Revegetation of exposed areas and maintenance of that vegetation shall be an integral part of the clearing activities during each phase of construction, per the Scheduling BMP (C 162).

Seasonal Work Limitations

- From October 1 through April 30, clearing, grading, and other soil disturbing activities shall only be permitted if shown to the satisfaction of the local permitting authority that silt-laden runoff will be prevented from leaving the site through a combination of the following:
    - Site conditions including existing vegetative coverage, slope, soil type, and proximity to receiving waters; and

- Limitations on activities and the extent of disturbed areas; and
- Proposed erosion and sediment control measures.

- Based on the information provided and/or local weather conditions, the local permitting authority may expand or restrict the seasonal limitation on site disturbance.
- The following activities are exempt from the seasonal clearing and grading limitations:
  - Routine maintenance and necessary repair of erosion and sediment control BMPs;
  - Routine maintenance of public facilities or existing utility structures that do not expose the soil or result in the removal of the vegetative cover to soil; and
  - Activities where there is 100 percent infiltration of surface water runoff within the site in approved and installed erosion and sediment control facilities.

Coordination with Utilities and Other Jurisdictions

- Care has been taken to coordinate with utilities, other construction projects, and the local jurisdiction in preparing this SWPPP and scheduling the construction work.

Inspection and Monitoring

- All BMPs shall be inspected, maintained, and repaired as needed to assure continued performance of their intended function. Site inspections shall be conducted by a person who is knowledgeable in the principles and practices of erosion and sediment control. This person has the necessary skills to:
  - Assess the site conditions and construction activities that could impact the quality of stormwater, and
  - Assess the effectiveness of erosion and sediment control measures used to control the quality of stormwater discharges.
- A Certified Erosion and Sediment Control Lead shall be on-site or on-call at all times.

- Whenever inspection and/or monitoring reveals that the BMPs identified in this SWPPP are inadequate, due to the actual discharge of or potential to discharge a significant amount of any pollutant, appropriate BMPs or design changes shall be implemented as soon as possible.

Maintaining an Updated Construction SWPPP

- This SWPPP shall be retained on-site or within reasonable access to the site.

- The SWPPP shall be modified whenever there is a change in the design, construction, operation, or maintenance at the construction site that has, or could have, a significant effect on the discharge of pollutants to waters of the state.

- The SWPPP shall be modified if, during inspections or investigations conducted by the owner/operator, or the applicable local or state regulatory authority, it is determined that the SWPPP is ineffective in eliminating or significantly minimizing pollutants in stormwater discharges from the site. The SWPPP shall be modified as necessary to include additional or modified BMPs designed to correct problems identified. Revisions to the SWPPP shall be completed within seven (7) days following the inspection.

3.2 Site Specific BMPs

Site specific BMPs are shown on the TESC Plan Sheets and Details in Appendix A. These site specific plan sheets will be updated annually.

4.0 Construction Phasing and BMP Implementation

The BMP implementation schedule will be driven by the Contractor's construction schedule. The following provides a preliminary sequential list of the proposed construction schedule milestones and the corresponding BMP implementation schedule. The list contains key milestones such as wet season construction. The Contractor will be responsible for providing a construction schedule including Erosion and Sediment Control tasks.

- Estimate of Construction start date: xx / xx / xxxx
- Estimate of Construction finish date: xx / xx / xxxx
- Mobilize equipment on site: xx / xx / xxxx
- Mobilize and store all ESC and soil stabilization products (store materials on hand BMP C150): xx / xx / xxxx
- Install ESC measures: xx / xx / xxxx
- Install stabilized construction entrance: xx / xx / xxxx
- Begin clearing and grubbing: xx / xx / xxxx
- Temporary erosion control measures (hydroseeding) xx / xx / xxxx
- Site inspections reduced to monthly: xx / xx / xxxx
- Excavate and install new utilities and services (Phase 1): xx / xx / xxxx
- Complete Phase 1 utility construction xx / xx / xxxx
- Begin implementing soil stabilization and sediment control BMPs throughout the site in preparation for wet season: xx / xx / xxxx
- Wet Season starts: 10 / 01 / xxxx
- Site inspections and monitoring conducted weekly and for applicable rain events as detailed in Section 6 of this SWPPP: 10 / 01 / xxxx
- Implement Element #12 BMPs and manage site to minimize soil disturbance during the wet season 10 / 01 / xxxx
- No site work such as grading or excavation planned:
- Dry Season starts: 05 / 01 / xxxx
- Final landscaping and planting begins: xx / xx / xxxx
- Permanent erosion control measures (hydroseeding): xx / xx / xxxx

5.0 Pollution Prevention Team

5.1 Roles and Responsibilities

The pollution prevention team consists of personnel responsible for implementation of the SWPPP, including the following:

- Certified Erosion and Sediment Control Lead (CESCL) – primary contractor contact, responsible for site inspections (BMPs, visual monitoring, sampling, etc.); to be called upon in case of failure of any ESC measures.
- Resident Engineer – For projects with engineered structures only (sediment ponds/traps, sand filters, etc.): site representative for the owner that is the project's supervising engineer responsible for inspections and issuing instructions and drawings to the contractor's site supervisor or representative
- Emergency Ecology Contact – individual to be contacted at Ecology in case of emergency. Go to the following website to get the name and number for the Ecology contact information: http://www.ecy.wa.gov/org.html.
- Emergency Owner Contact – individual that is the site owner or representative of the site owner to be contacted in the case of an emergency.
- Non-Emergency Ecology Contact – individual that is the site owner or representative of the site owner than can be contacted if required.
- Monitoring Personnel – personnel responsible for conducting water quality monitoring; for most sites this person is also the Certified Erosion and Sediment Control Lead.

5.2 Team Members

Names and contact information for those identified as members of the pollution prevention team are provided in the following table.

Title	Name(s)	Phone Number
Certified Erosion and Sediment Control Lead (CESCL)	TBD	~
Resident Engineer	Tamara Nack	**206-284-0860**
Emergency Ecology Contact	~	~
Emergency Owner Contact	~	~
Non-Emergency Ecology Contact	~	~
Monitoring Personnel	~	~

6.0 Site Inspections and Monitoring

Monitoring includes visual inspection, monitoring for water quality parameters of concern, and documentation of the inspection and monitoring findings in a site log book. A site log book will be maintained for all on-site construction activities and will include:

- A record of the implementation of the SWPPP and other permit requirements;
- Site inspections; and,
- Stormwater quality monitoring.

For convenience, the inspection form and water quality monitoring forms included in this SWPPP include the required information for the site log book. This SWPPP may function as the site log book if desired, or the forms may be separated and included in a separate site log book. However, if separated, the site log book but must be maintained on-site or within reasonable access to the site and be made available upon request to Ecology or the local jurisdiction.

6.1 Site Inspection

All BMPs will be inspected, maintained, and repaired as needed to assure continued performance of their intended function. Site inspections will be conducted by a person who is knowledgeable in the principles and practices of erosion and sediment control. The onsite inspector will have the skills to assess the potential for water quality impacts as a result of the type of construction activities occurring on site, and the knowledge of the appropriate and effective ESC measures needed to control the quality of stormwater discharges.

All BMPs will be inspected, maintained, and repaired as needed to assure continued performance of their intended function. The inspector will be a Certified Erosion and Sediment Control Lead (CESCL) per BMP C160. The name and contact information for the CESCL is provided in Section 5 of this SWPPP.

Site inspection will occur in all areas disturbed by construction activities and at all stormwater discharge points. Stormwater will be examined for the presence of suspended sediment, turbidity, discoloration, and oily sheen. The site inspector will evaluate and document the effectiveness of the installed BMPs and determine if it is necessary to repair or replace any of the BMPs to improve the quality of stormwater discharges. All maintenance and repairs will be documented in the site log book or forms provided in this document. All new BMPs or design changes will be documented in the SWPPP as soon as possible.

6.1.1 Site Inspection Frequency

Site inspections will be conducted at least once a week and within 24 hours following any discharge from the site. For sites with temporary stabilization measures, the site inspection frequency can be reduced to once every month.

6.1.2 Site Inspection Documentation

The site inspector will record each site inspection using the site log inspection forms provided in Appendix E. The site inspection log forms may be separated from this SWPPP document, but will be maintained on-site or within reasonable access to the site and be made available upon request to Ecology or the local jurisdiction.

6.2 Stormwater Quality Monitoring

6.2.1 Turbidity Sampling

Monitoring requirements for the proposed project will include either turbidity or water transparency sampling to monitor site discharges for water quality compliance with the 2005 Construction Stormwater General Permit (Appendix D). Sampling will be conducted at all discharge points at least once per calendar week.

Turbidity or transparency monitoring will follow the analytical methodologies described in Section S4 of the 2005 Construction Stormwater General Permit (Appendix D). The key benchmark values that require action are 25 NTU for turbidity (equivalent to 32 cm transparency) and 250 NTU for turbidity (equivalent to 6 cm transparency). If the 25 NTU benchmark for turbidity (equivalent to 32 cm transparency) is exceeded, the following steps will be conducted:

1. Ensure all BMPs specified in this SWPPP are installed and functioning as intended.

2. Assess whether additional BMPs should be implemented, and document revisions to the SWPPP as necessary.

3. Sample discharge location daily until the analysis results are less than 25 NTU (turbidity) or greater than 32 cm (transparency).

If the turbidity is greater than 25 NTU (or transparency is less than 32 cm) but less than 250 NTU (transparency greater than 6 cm) for more than 3 days, additional treatment BMPs will be implemented within 24 hours of the third consecutive sample that exceeded the benchmark value. Additional treatment BMPs to be considered will include, but are not limited to, off-site treatment, infiltration, filtration and chemical treatment.

If the 250 NTU benchmark for turbidity (or less than 6 cm transparency) is exceeded at any time, the following steps will be conducted:

1. Notify Ecology by phone within 24 hours of analysis (see Section 5.0 of this SWPPP for contact information).

2. Continue daily sampling until the turbidity is less than 25 NTU (or transparency is greater than 32 cm).

3. Initiate additional treatment BMPs such as off-site treatment, infiltration, filtration and chemical treatment within 24 hours of the first 250 NTU exceedance.

4. Implement additional treatment BMPs as soon as possible, but within 7 days of the first 250 NTU exceedance.

5. Describe inspection results and remedial actions taken in the site log book and in monthly discharge monitoring reports as described in Section 7.0 of this SWPPP.

7.0 Reporting and Recordkeeping

7.1 Recordkeeping

7.1.1 Site Log Book

A site log book will be maintained for all on-site construction activities and will include:

- A record of the implementation of the SWPPP and other permit requirements;
- Site inspections; and,
- Stormwater quality monitoring.

For convenience, the inspection form and water quality monitoring forms included in this SWPPP include the required information for the site log book.

7.1.2 Records Retention

Records of all monitoring information (site log book, inspection reports/checklists, etc.), this Stormwater Pollution Prevention Plan, and any other documentation of compliance with permit requirements will be retained during the life of the construction project and for a minimum of three years following the termination of permit coverage in accordance with permit condition S5.C.

7.1.3 Access to Plans and Records

The SWPPP, General Permit, Notice of Authorization letter, and Site Log Book will be retained on site or within reasonable access to the site and will be made immediately available upon request to Ecology or the local jurisdiction. A copy of this SWPPP will be provided to Ecology within 14 days of receipt of a written request for the SWPPP from Ecology. Any other information requested by Ecology will be submitted within a reasonable time. A copy of the SWPPP or access to the SWPPP will be provided to the public when requested in writing in accordance with permit condition S5.G.

7.1.4 Updating the SWPPP

In accordance with Conditions S3, S4.B, and S9.B.3 of the General Permit, this SWPPP will be modified if the SWPPP is ineffective in eliminating or significantly minimizing pollutants in stormwater discharges from the site or there has been a change in design, construction, operation, or maintenance at the site that has a significant effect on the discharge, or potential for discharge,

of pollutants to the waters of the State. The SWPPP will be modified within seven days of determination based on inspection(s) that additional or modified BMPs are necessary to correct problems identified, and an updated timeline for BMP implementation will be prepared.

7.2 Reporting

7.2.1 Discharge Monitoring Reports

If cumulative soil disturbance is 5 acres or larger: Discharge Monitoring Reports (DMRs) will be submitted to Ecology monthly. If there was no discharge during a given monitoring period, the Permittee shall submit the form as required, with the words "No discharge" entered in the place of monitoring results. The DMR due date is 15 days following the end of each month.

7.2.2 Notification of Noncompliance

If any of the terms and conditions of the permit is not met, and it causes a threat to human health or the environment, the following steps will be taken in accordance with permit section S5.F:

1. Ecology will be immediately notified of the failure to comply.

2. Immediate action will be taken to control the noncompliance issue and to correct the problem. If applicable, sampling and analysis of any noncompliance will be repeated immediately and the results submitted to Ecology within five (5) days of becoming aware of the violation.

3. A detailed written report describing the noncompliance will be submitted to Ecology within five (5) days, unless requested earlier by Ecology.

Appendix A – Site Plans

Appendix B – Construction BMPs

High Visibility Plastic or Metal Fence (BMP C103)

Stabilized Construction Entrance (BMP C105)

Construction Road/Parking Area Stabilization (BMP C107)

Straw Bale Barrier (BMP C230)

Silt Fence (BMP C233)

Straw Wattles (BMP C235)

Storm Drain Inlet Protection (BMP C220)

Temporary and Permanent Seeding (BMP C120)

Plastic Covering (BMP C123)

Dust Control (BMP C140)

BMP C103: High Visibility Fence

Purpose

Fencing is intended to:

1. Restrict clearing to approved limits.
2. Prevent disturbance of sensitive areas, their buffers, and other areas required to be left undisturbed.
3. Limit construction traffic to designated construction entrances, exits, or internal roads.
4. Protect areas where marking with survey tape may not provide adequate protection.

Conditions of Use

To establish clearing limits plastic, fabric, or metal fence may be used:

- At the boundary of sensitive areas, their buffers, and other areas required to be left uncleared.
- As necessary to control vehicle access to and on the site.

Design and Installation Specifications

High visibility plastic fence shall be composed of a high-density polyethylene material and shall be at least four feet in height. Posts for the fencing shall be steel or wood and placed every 6 feet on center (maximum) or as needed to ensure rigidity. The fencing shall be fastened to the post every six inches with a polyethylene tie. On long continuous lengths of fencing, a tension wire or rope shall be used as a top stringer to prevent sagging between posts. The fence color shall be high visibility orange. The fence tensile strength shall be 360 lbs./ft. using the ASTM D4595 testing method.

If appropriate install fabric silt fence in accordance with BMP C233 to act as high visibility fence. Silt fence shall be at least 3 feet high and must be highly visible to meet the requirements of this BMP.

Metal fences shall be designed and installed according to the manufacturer's specifications.

Metal fences shall be at least 3 feet high and must be highly visible.

Fences shall not be wired or stapled to trees.

Maintenance Standards

If the fence has been damaged or visibility reduced, it shall be repaired or replaced immediately and visibility restored.

BMP C105: Stabilized Construction Entrance / Exit

Purpose

Stabilized Construction entrances are established to reduce the amount of sediment transported onto paved roads by vehicles or equipment. This is done by constructing a stabilized pad of quarry spalls at entrances and exits for construction sites.

Conditions of Use

Construction entrances shall be stabilized wherever traffic will be entering or leaving a construction site if paved roads or other paved areas are within 1,000 feet of the site.

For residential construction provide stabilized construction entrances for each residence, rather than only at the main subdivision entrance. Stabilized surfaces shall be of sufficient length/width to provide vehicle access/parking, based on lot size/configuration.

On large commercial, highway, and road projects, the designer should include enough extra materials in the contract to allow for additional stabilized entrances not shown in the initial Construction SWPPP. It is difficult to determine exactly where access to these projects will take place; additional materials will enable the contractor to install them where needed.

Design and Installation Specifications

See Figure 4.1.1 for details. Note: the 100' minimum length of the entrance shall be reduced to the maximum practicable size when the size or configuration of the site does not allow the full length (100').

Construct stabilized construction entrances with a 12-inch thick pad of 4-inch to 8-inch quarry spalls, a 4-inch course of asphalt treated base (ATB), or use existing pavement. Do not use crushed concrete, cement, or calcium chloride for construction entrance stabilization because these products raise pH levels in stormwater and concrete discharge to surface waters of the State is prohibited.

A separation geotextile shall be placed under the spalls to prevent fine sediment from pumping up into the rock pad. The geotextile shall meet the following standards:

Grab Tensile Strength (ASTM D4751)	200 psi min.
Grab Tensile Elongation (ASTM D4632)	30% max.
Mullen Burst Strength (ASTM D3786-80a)	400 psi min.
AOS (ASTM D4751)	20-45 (U.S. standard sieve size)

- Consider early installation of the first lift of asphalt in areas that will paved; this can be used as a stabilized entrance. Also consider the installation of excess concrete as a stabilized entrance. During large concrete pours, excess concrete is often available for this purpose.

- Fencing (see BMP C103) shall be installed as necessary to restrict traffic to the construction entrance.
- Whenever possible, the entrance shall be constructed on a firm, compacted subgrade. This can substantially increase the effectiveness of the pad and reduce the need for maintenance.
- Construction entrances should avoid crossing existing sidewalks and back of walk drains if at all possible. If a construction entrance must cross a sidewalk or back of walk drain, the full length of the sidewalk and back of walk drain must be covered and protected from sediment leaving the site.

Maintenance Standards

Quarry spalls shall be added if the pad is no longer in accordance with the specifications.

- If the entrance is not preventing sediment from being tracked onto pavement, then alternative measures to keep the streets free of sediment shall be used. This may include replacement/cleaning of the existing quarry spalls, street sweeping, an increase in the dimensions of the entrance, or the installation of a wheel wash.
- Any sediment that is tracked onto pavement shall be removed by shoveling or street sweeping. The sediment collected by sweeping shall be removed or stabilized on site. The pavement shall not be cleaned by washing down the street, except when high efficiency sweeping is ineffective and there is a threat to public safety. If it is necessary to wash the streets, the construction of a small sump to contain the wash water shall be considered. The sediment would then be washed into the sump where it can be controlled.
- Perform street sweeping by hand or with a high efficiency sweeper. Do not use a non-high efficiency mechanical sweeper because this creates dust and throws soils into storm systems or conveyance ditches.
- Any quarry spalls that are loosened from the pad, which end up on the roadway shall be removed immediately.
- If vehicles are entering or exiting the site at points other than the construction entrance(s), fencing (see BMP C103) shall be installed to control traffic.
- Upon project completion and site stabilization, all construction accesses intended as permanent access for maintenance shall be permanently stabilized.

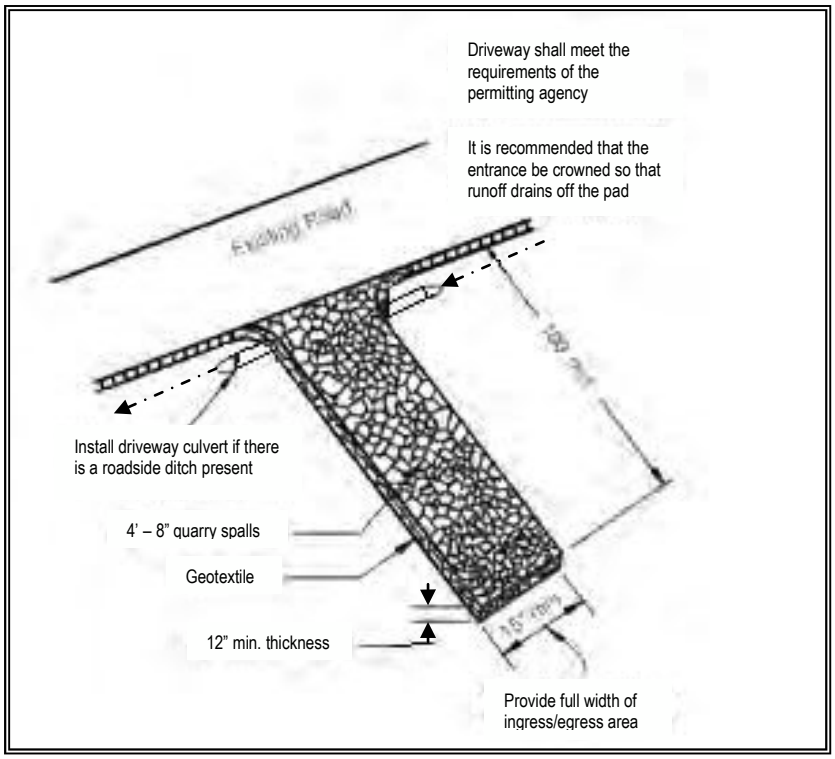


Figure 4.1.1 – Stabilized Construction Entrance

Approved as Equivalent

Ecology has approved products as able to meet the requirements of BMP C105. The products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. Local jurisdictions may choose not to accept this product approved as equivalent, or may require additional testing prior to consideration for local use. The products are available for review on Ecology's website at http://www.ecy.wa.gov/programs/wq/stormwater/newtech/equivalent.html

BMP C106: Wheel Wash

Purpose

Wheel washes reduce the amount of sediment transported onto paved roads by motor vehicles.

Conditions of Use

When a stabilized construction entrance (see BMP C105) is not preventing sediment from being tracked onto pavement.

- Wheel washing is generally an effective BMP when installed with careful attention to topography. For example, a wheel wash can be detrimental if installed at the top of a slope abutting a right-of-way where the water from the dripping truck can run unimpeded into the street.

BMP C107: Construction Road/Parking Area Stabilization

Purpose

Stabilizing subdivision roads, parking areas, and other on-site vehicle transportation routes immediately after grading reduces erosion caused by construction traffic or runoff.

Conditions of Use

Roads or parking areas shall be stabilized wherever they are constructed, whether permanent or temporary, for use by construction traffic.

- High Visibility Fencing (see BMP C103) shall be installed, if necessary, to limit the access of vehicles to only those roads and parking areas that are stabilized.

Design and Installation Specifications

- On areas that will receive asphalt as part of the project, install the first lift as soon as possible.
- A 6-inch depth of 2- to 4-inch crushed rock, gravel base, or crushed surfacing base course shall be applied immediately after grading or utility installation. A 4-inch course of asphalt treated base (ATB) may also be used, or the road/parking area may be paved. It may also be possible to use cement or calcium chloride for soil stabilization. If cement or cement kiln dust is used for roadbase stabilization, pH monitoring and BMPs (BMPs C252 and C253) are necessary to evaluate and minimize the effects on stormwater. If the area will not be used for permanent roads, parking areas, or structures, a 6-inch depth of hog fuel may also be used, but this is likely to require more maintenance. Whenever possible, construction roads and parking areas shall be placed on a firm, compacted subgrade.
- Temporary road gradients shall not exceed 15 percent. Roadways shall be carefully graded to drain. Drainage ditches shall be provided on each side of the roadway in the case of a crowned section, or on one side in the case of a super-elevated section. Drainage ditches shall be directed to a sediment control BMP.
- Rather than relying on ditches, it may also be possible to grade the road so that runoff sheet-flows into a heavily vegetated area with a well-developed topsoil. Landscaped areas are not adequate. If this area has at least 50 feet of vegetation that water can flow through, then it is generally preferable to use the vegetation to treat runoff, rather than a sediment pond or trap. The 50 feet shall not include wetlands or their buffers. If runoff is allowed to sheetflow through adjacent vegetated areas, it is vital to design the roadways and parking areas so that no concentrated runoff is created.
- Storm drain inlets shall be protected to prevent sediment-laden water entering the storm drain system (see BMP C220).

Maintenance Standards

Inspect stabilized areas regularly, especially after large storm events.

Crushed rock, gravel base, etc. shall be added as required to maintain a

stable driving surface and to stabilize any areas that have eroded.

Following construction, these areas shall be restored to pre-construction condition or better to prevent future erosion.

Perform street cleaning at the end of each day or more often if necessary.

BMP C120: Temporary and Permanent Seeding

Purpose

Seeding reduces erosion by stabilizing exposed soils. A well-established vegetative cover is one of the most effective methods of reducing erosion.

Conditions of Use

Use seeding throughout the project on disturbed areas that have reached final grade or that will remain unworked for more than 30 days.

The optimum seeding windows for western Washington are April 1 through June 30 and September 1 through October 1.

Between July 1 and August 30 seeding requires irrigation until 75 percent grass cover is established.

Between October 1 and March 30 seeding requires a cover of mulch with straw or an erosion control blanket until 75 percent grass cover is established.

Review all disturbed areas in late August to early September and complete all seeding by the end of September. Otherwise, vegetation will not establish itself enough to provide more than average protection.

- Mulch is required at all times for seeding because it protects seeds from heat, moisture loss, and transport due to runoff. Mulch can be applied on top of the seed or simultaneously by hydroseeding. See BMP C121: Mulching for specifications.
- Seed and mulch, all disturbed areas not otherwise vegetated at final site stabilization. Final stabilization means the completion of all soil disturbing activities at the site and the establishment of a permanent vegetative cover, or equivalent permanent stabilization measures (such as pavement, riprap, gabions or geotextiles) which will prevent erosion.

Design and Installation Specifications

Seed retention/detention ponds as required.

Install channels intended for vegetation before starting major earthwork and hydroseed with a Bonded Fiber Matrix. For vegetated channels that will have high flows, install erosion control blankets over hydroseed. Before allowing water to flow in vegetated channels, establish 75 percent vegetation cover. If vegetated channels cannot be established by seed before water flow; install sod in the channel bottom—over hydromulch and erosion control blankets.

- Confirm the installation of all required surface water control measures to prevent seed from washing away.
- Hydroseed applications shall include a minimum of 1,500 pounds per acre of mulch with 3 percent tackifier. See BMP C121: Mulching for specifications.
- Areas that will have seeding only and not landscaping may need compost or meal-based mulch included in the hydroseed in order to establish vegetation. Re-install native topsoil on the disturbed soil surface before application.
- When installing seed via hydroseeding operations, only about 1/3 of the seed actually ends up in contact with the soil surface. This reduces the ability to establish a good stand of grass quickly. To overcome this, consider increasing seed quantities by up to 50 percent.
- Enhance vegetation establishment by dividing the hydromulch operation into two phases:

  1. Phase 1- Install all seed and fertilizer with 25-30 percent mulch and tackifier onto soil in the first lift.
  2. Phase 2- Install the rest of the mulch and tackifier over the first lift.

  Or, enhance vegetation by:

  1. Installing the mulch, seed, fertilizer, and tackifier in one lift.
  2. Spread or blow straw over the top of the hydromulch at a rate of 800-1000 pounds per acre.
  3. Hold straw in place with a standard tackifier.

  Both of these approaches will increase cost moderately but will greatly improve and enhance vegetative establishment. The increased cost may be offset by the reduced need for:

  - Irrigation.
  - Reapplication of mulch.
  - Repair of failed slope surfaces.

  This technique works with standard hydromulch (1,500 pounds per acre minimum) and BFM/MBFMs (3,000 pounds per acre minimum).
- Seed may be installed by hand if:
  - Temporary and covered by straw, mulch, or topsoil.
  - Permanent in small areas (usually less than 1 acre) and covered with mulch, topsoil, or erosion blankets.
- The seed mixes listed in the tables below include recommended mixes for both temporary and permanent seeding.

- Apply these mixes, with the exception of the wetland mix, at a rate of 120 pounds per acre. This rate can be reduced if soil amendments or slow-release fertilizers are used.
- Consult the local suppliers or the local conservation district for their recommendations because the appropriate mix depends on a variety of factors, including location, exposure, soil type, slope, and expected foot traffic. Alternative seed mixes approved by the local authority may be used.
- Other mixes may be appropriate, depending on the soil type and hydrology of the area.

- Table 4.1.2 lists the standard mix for areas requiring a temporary vegetative cover.

Table 4.1.2
Temporary Erosion Control Seed Mix

	% Weight	% Purity	% Germination
Chewings or annual blue grass *Festuca rubra var. commutata* or *Poa anna*	40	98	90
Perennial rye - *Lolium perenne*	50	98	90
Redtop or colonial bentgrass *Agrostis alba* or *Agrostis tenuis*	5	92	85
White dutch clover *Trifolium repens*	5	98	90

- Table 4.1.3 lists a recommended mix for landscaping seed.

Table 4.1.3
Landscaping Seed Mix

	% Weight	% Purity	% Germination
Perennial rye blend *Lolium perenne*	70	98	90
Chewings and red fescue blend *Festuca rubra var. commutata* or *Festuca rubra*	30	98	90

- Table 4.1.4 lists a turf seed mix for dry situations where there is no need for watering. This mix requires very little maintenance.

Table 4.1.4
Low-Growing Turf Seed Mix

	% Weight	% Purity	% Germination
Dwarf tall fescue (several varieties) *Festuca arundinacea var.*	45	98	90
Dwarf perennial rye (Barclay) *Lolium perenne var. barclay*	30	98	90
Red fescue *Festuca rubra*	20	98	90
Colonial bentgrass *Agrostis tenuis*	5	98	90

- Table 4.1.5 lists a mix for bioswales and other intermittently wet areas.

Table 4.1.5
Bioswale Seed Mix*

	% Weight	% Purity	% Germination
Tall or meadow fescue *Festuca arundinacea* or *Festuca elatior*	75-80	98	90
Seaside/Creeping bentgrass *Agrostis palustris*	10-15	92	85
Redtop bentgrass *Agrostis alba* or *Agrostis gigantea*	5-10	90	80

** Modified Briargreen, Inc. Hydroseeding Guide Wetlands Seed Mix*

- Table 4.1.6 lists a low-growing, relatively non-invasive seed mix appropriate for very wet areas that are not regulated wetlands. Apply this mixture at a rate of 60 pounds per acre. Consult Hydraulic Permit Authority (HPA) for seed mixes if applicable.

Table 4.1.6
Wet Area Seed Mix*

	% Weight	% Purity	% Germination
Tall or meadow fescue *Festuca arundinacea* or *Festuca elatior*	60-70	98	90
Seaside/Creeping bentgrass *Agrostis palustris*	10-15	98	85
Meadow foxtail *Alepocurus pratensis*	10-15	90	80
Alsike clover *Trifolium hybridum*	1-6	98	90
Redtop bentgrass *Agrostis alba*	1-6	92	85

** Modified Briargreen, Inc. Hydroseeding Guide Wetlands Seed Mix*

- Table 4.1.7 lists a recommended meadow seed mix for infrequently maintained areas or non-maintained areas where colonization by native plants is desirable. Likely applications include rural road and utility right-of-way. Seeding should take place in September or very early October in order to obtain adequate establishment prior to the winter months. Consider the appropriateness of clover, a fairly invasive species, in the mix. Amending the soil can reduce the need for clover.

Table 4.1.7
Meadow Seed Mix

	% Weight	% Purity	% Germination
Redtop or Oregon bentgrass *Agrostis alba* or *Agrostis oregonensis*	20	92	85
Red fescue *Festuca rubra*	70	98	90
White dutch clover *Trifolium repens*	10	98	90

- **Roughening and Rototilling:**
  - The seedbed should be firm and rough. Roughen all soil no matter what the slope. Track walk slopes before seeding if engineering purposes require compaction. Backblading or smoothing of slopes greater than 4H:1V is not allowed if they are to be seeded.
  - Restoration-based landscape practices require deeper incorporation than that provided by a simple single-pass rototilling treatment. Wherever practical, initially rip the subgrade to improve long-term permeability, infiltration, and water inflow qualities. At a minimum, permanent areas shall use soil amendments to achieve organic matter and permeability performance defined in engineered soil/landscape systems. For systems that are deeper than 8 inches complete the rototilling process in multiple lifts, or prepare the engineered soil system per specifications and place to achieve the specified depth.
- **Fertilizers:**
  - Conducting soil tests to determine the exact type and quantity of fertilizer is recommended. This will prevent the over-application of fertilizer.
  - Organic matter is the most appropriate form of fertilizer because it provides nutrients (including nitrogen, phosphorus, and potassium) in the least water-soluble form.
  - In general, use 10-4-6 N-P-K (nitrogen-phosphorus-potassium) fertilizer at a rate of 90 pounds per acre. Always use slow-release fertilizers because they are more efficient and have fewer environmental impacts. Do not add fertilizer to the hydromulch machine, or agitate, more than 20 minutes before use. Too much agitation destroys the slow-release coating.
  - There are numerous products available that take the place of chemical fertilizers. These include several with seaweed extracts that are beneficial to soil microbes and organisms. If 100 percent cottonseed meal is used as the mulch in hydroseed, chemical fertilizer may not be necessary. Cottonseed meal provides a good source of long-term, slow-release, available nitrogen.
- **Bonded Fiber Matrix and Mechanically Bonded Fiber Matrix:**
  - On steep slopes use Bonded Fiber Matrix (BFM) or Mechanically Bonded Fiber Matrix (MBFM) products. Apply BFM/MBFM products at a minimum rate of 3,000 pounds per acre of mulch with approximately 10 percent tackifier. Achieve a minimum of 95 percent soil coverage during application. Numerous products are available commercially. Installed products per manufacturer's instructions. Most products require 24-36 hours to cure before rainfall and cannot be installed on wet or saturated soils.

Generally, products come in 40-50 pound bags and include all necessary ingredients except for seed and fertilizer.

- BFMs and MBFMs provide good alternatives to blankets in most areas requiring vegetation establishment. Advantages over blankets include:
  - BFM and MBFMs do not require surface preparation.
  - Helicopters can assist in installing BFM and MBFMs in remote areas.
  - On slopes steeper than 2.5H:1V, blanket installers may require ropes and harnesses for safety.
  - Installing BFM and MBFMs can save at least $1,000 per acre compared to blankets.

Maintenance Standards

Reseed any seeded areas that fail to establish at least 80 percent cover (100 percent cover for areas that receive sheet or concentrated flows). If reseeding is ineffective, use an alternate method such as sodding, mulching, or nets/blankets. If winter weather prevents adequate grass growth, this time limit may be relaxed at the discretion of the local authority when sensitive areas would otherwise be protected.

- Reseed and protect by mulch any areas that experience erosion after achieving adequate cover. Reseed and protect by mulch any eroded area.
- Supply seeded areas with adequate moisture, but do not water to the extent that it causes runoff.

Approved as Equivalent

Ecology has approved products as able to meet the requirements of BMP C120. The products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. Local jurisdictions may choose not to accept this product approved as equivalent, or may require additional testing prior to consideration for local use. The products are available for review on Ecology's website at http://www.ecy.wa.gov/programs/wq/stormwater/newtech/equivalent.html

BMP C121: Mulching

Purpose

Mulching soils provides immediate temporary protection from erosion. Mulch also enhances plant establishment by conserving moisture, holding fertilizer, seed, and topsoil in place, and moderating soil temperatures. There is an enormous variety of mulches that can be used. This section discusses only the most common types of mulch.

Conditions of Use

As a temporary cover measure, mulch should be used:

- For less than 30 days on disturbed areas that require cover.
- At all times for seeded areas, especially during the wet season and

BMP C123: Plastic Covering

Purpose

Plastic covering provides immediate, short-term erosion protection to slopes and disturbed areas.

Conditions of Use

Plastic covering may be used on disturbed areas that require cover measures for less than 30 days, except as stated below.

- Plastic is particularly useful for protecting cut and fill slopes and stockpiles. Note: The relatively rapid breakdown of most polyethylene sheeting makes it unsuitable for long-term (greater than six months) applications.
- Due to rapid runoff caused by plastic covering, do not use this method upslope of areas that might be adversely impacted by concentrated runoff. Such areas include steep and/or unstable slopes.
- Plastic sheeting may result in increased runoff volumes and velocities, requiring additional on-site measures to counteract the increases. Creating a trough with wattles or other material can convey clean water away from these areas.
- To prevent undercutting, trench and backfill rolled plastic covering products.
- While plastic is inexpensive to purchase, the added cost of installation, maintenance, removal, and disposal make this an expensive material, up to $1.50-2.00 per square yard.
- Whenever plastic is used to protect slopes install water collection measures at the base of the slope. These measures include plastic-covered berms, channels, and pipes used to covey clean rainwater away from bare soil and disturbed areas. Do not mix clean runoff from a plastic covered slope with dirty runoff from a project.
- Other uses for plastic include:
    1. Temporary ditch liner.
    2. Pond liner in temporary sediment pond.
    3. Liner for bermed temporary fuel storage area if plastic is not reactive to the type of fuel being stored.
    4. Emergency slope protection during heavy rains.
    5. Temporary drainpipe (“elephant trunk”) used to direct water.

Design and Installation Specifications

- Plastic slope cover must be installed as follows:
    1. Run plastic up and down slope, not across slope.
    2. Plastic may be installed perpendicular to a slope if the slope length is less than 10 feet.
    3. Minimum of 8-inch overlap at seams.

4. On long or wide slopes, or slopes subject to wind, tape all seams.
5. Place plastic into a small (12-inch wide by 6-inch deep) slot trench at the top of the slope and backfill with soil to keep water from flowing underneath.
6. Place sand filled burlap or geotextile bags every 3 to 6 feet along seams and tie them together with twine to hold them in place.
7. Inspect plastic for rips, tears, and open seams regularly and repair immediately. This prevents high velocity runoff from contacting bare soil which causes extreme erosion.
8. Sandbags may be lowered into place tied to ropes. However, all sandbags must be staked in place.

- Plastic sheeting shall have a minimum thickness of 0.06 millimeters.
- If erosion at the toe of a slope is likely, a gravel berm, riprap, or other suitable protection shall be installed at the toe of the slope in order to reduce the velocity of runoff.

Maintenance Standards

- Torn sheets must be replaced and open seams repaired.
- Completely remove and replace the plastic if it begins to deteriorate due to ultraviolet radiation.
- Completely remove plastic when no longer needed.
- Dispose of old tires used to weight down plastic sheeting appropriately.

Approved as Equivalent

Ecology has approved products as able to meet the requirements of BMP C123. The products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. Local jurisdictions may choose not to accept this product approved as equivalent, or may require additional testing prior to consideration for local use. The products are available for review on Ecology's website at http://www.ecy.wa.gov/programs/wq/stormwater/newtech/equivalent.html

BMP C124: Sodding

Purpose

The purpose of sodding is to establish permanent turf for immediate erosion protection and to stabilize drainage ways where concentrated overland flow will occur.

Conditions of Use

Sodding may be used in the following areas:

- Disturbed areas that require short-term or long-term cover.
- Disturbed areas that require immediate vegetative cover.
- All waterways that require vegetative lining. Waterways may also be seeded rather than sodded, and protected with a net or blanket.

BMP C140: Dust Control

Purpose

Dust control prevents wind transport of dust from disturbed soil surfaces onto roadways, drainage ways, and surface waters.

Conditions of Use

- In areas (including roadways) subject to surface and air movement of dust where on-site and off-site impacts to roadways, drainage ways, or surface waters are likely.

Design and Installation Specifications

- Vegetate or mulch areas that will not receive vehicle traffic. In areas where planting, mulching, or paving is impractical, apply gravel or landscaping rock.
- Limit dust generation by clearing only those areas where immediate activity will take place, leaving the remaining area(s) in the original condition. Maintain the original ground cover as long as practical.
- Construct natural or artificial windbreaks or windscreens. These may be designed as enclosures for small dust sources.
- Sprinkle the site with water until surface is wet. Repeat as needed. To prevent carryout of mud onto street, refer to Stabilized Construction Entrance (BMP C105).
- Irrigation water can be used for dust control. Irrigation systems should be installed as a first step on sites where dust control is a concern.
- Spray exposed soil areas with a dust palliative, following the manufacturer's instructions and cautions regarding handling and application. Used oil is prohibited from use as a dust suppressant. Local governments may approve other dust palliatives such as calcium chloride or PAM.
- PAM (BMP C126) added to water at a rate of 0.5 lbs. per 1,000 gallons of water per acre and applied from a water truck is more effective than water alone. This is due to increased infiltration of water into the soil and reduced evaporation. In addition, small soil particles are bonded together and are not as easily transported by wind. Adding PAM may actually reduce the quantity of water needed for dust control. Use of PAM could be a cost-effective dust control method.

Techniques that can be used for unpaved roads and lots include:

- Lower speed limits. High vehicle speed increases the amount of dust stirred up from unpaved roads and lots.
- Upgrade the road surface strength by improving particle size, shape, and mineral types that make up the surface and base materials.
- Add surface gravel to reduce the source of dust emission. Limit the amount of fine particles (those smaller than .075 mm) to 10 to 20 percent.

- Use geotextile fabrics to increase the strength of new roads or roads undergoing reconstruction.
- Encourage the use of alternate, paved routes, if available.
- Restrict use of paved roadways by tracked vehicles and heavy trucks to prevent damage to road surface and base.
- Apply chemical dust suppressants using the admix method, blending the product with the top few inches of surface material. Suppressants may also be applied as surface treatments.
- Pave unpaved permanent roads and other trafficked areas.
- Use vacuum street sweepers.
- Remove mud and other dirt promptly so it does not dry and then turn into dust.
- Limit dust-causing work on windy days.
- Contact your local Air Pollution Control Authority for guidance and training on other dust control measures. Compliance with the local Air Pollution Control Authority constitutes compliance with this BMP.

Maintenance Standards Respray area as necessary to keep dust to a minimum.

BMP C150: Materials on Hand

Purpose Keep quantities of erosion prevention and sediment control materials on the project site at all times to be used for regular maintenance and emergency situations such as unexpected heavy summer rains. Having these materials on-site reduces the time needed to implement BMPs when inspections indicate that existing BMPs are not meeting the Construction SWPPP requirements. In addition, contractors can save money by buying some materials in bulk and storing them at their office or yard.

Conditions of Use

- Construction projects of any size or type can benefit from having materials on hand. A small commercial development project could have a roll of plastic and some gravel available for immediate protection of bare soil and temporary berm construction. A large earthwork project, such as highway construction, might have several tons of straw, several rolls of plastic, flexible pipe, sandbags, geotextile fabric and steel "T" posts.
- Materials are stockpiled and readily available before any site clearing, grubbing, or earthwork begins. A large contractor or developer could keep a stockpile of materials that are available for use on several projects.
- If storage space at the project site is at a premium, the contractor could maintain the materials at their office or yard. The office or yard must be less than an hour from the project site.

- New pipe outfalls can provide an opportunity for low-cost fish habitat improvements. For example, an alcove of low-velocity water can be created by constructing the pipe outfall and associated energy dissipater back from the stream edge and digging a channel, over-widened to the upstream side, from the outfall. Overwintering juvenile and migrating adult salmonids may use the alcove as shelter during high flows. Bank stabilization, bioengineering, and habitat features may be required for disturbed areas. This work may require a HPA. See Volume V for more information on outfall system design.

Maintenance Standards

- Inspect and repair as needed.
- Add rock as needed to maintain the intended function.
- Clean energy dissipater if sediment builds up.

BMP C220: Storm Drain Inlet Protection

Purpose

Storm drain inlet protection prevents coarse sediment from entering drainage systems prior to permanent stabilization of the disturbed area.

Conditions of Use

Use storm drain inlet protection at inlets that are operational before permanent stabilization of the disturbed drainage area. Provide protection for all storm drain inlets downslope and within 500 feet of a disturbed or construction area, unless conveying runoff entering catch basins to a sediment pond or trap.

Also consider inlet protection for lawn and yard drains on new home construction. These small and numerous drains coupled with lack of gutters in new home construction can add significant amounts of sediment into the roof drain system. If possible delay installing lawn and yard drains until just before landscaping or cap these drains to prevent sediment from entering the system until completion of landscaping. Provide 18-inches of sod around each finished lawn and yard drain.

Table 4.2.2 lists several options for inlet protection. All of the methods for storm drain inlet protection tend to plug and require a high frequency of maintenance. Limit drainage areas to one acre or less. Possibly provide emergency overflows with additional end-of-pipe treatment where stormwater ponding would cause a hazard.

Table 4.2.2
Storm Drain Inlet Protection

Type of Inlet Protection	Emergency Overflow	Applicable for Paved/ Earthen Surfaces	Conditions of Use
Drop Inlet Protection			
Excavated drop inlet protection	Yes, temporary flooding will occur	Earthen	Applicable for heavy flows. Easy to maintain. Large area Requirement: 30' X 30'/acre
Block and gravel drop inlet protection	Yes	Paved or Earthen	Applicable for heavy concentrated flows. Will not pond.
Gravel and wire drop inlet protection	No		Applicable for heavy concentrated flows. Will pond. Can withstand traffic.
Catch basin filters	Yes	Paved or Earthen	Frequent maintenance required.
Curb Inlet Protection			
Curb inlet protection with a wooden weir	Small capacity overflow	Paved	Used for sturdy, more compact installation.
Block and gravel curb inlet protection	Yes	Paved	Sturdy, but limited filtration.
Culvert Inlet Protection			
Culvert inlet sediment trap			18 month expected life.

Design and Installation Specifications

Excavated Drop Inlet Protection - An excavated impoundment around the storm drain. Sediment settles out of the stormwater prior to entering the storm drain.

- Provide a depth of 1-2 ft as measured from the crest of the inlet structure.
- Slope sides of excavation no steeper than 2H:1V.
- Minimum volume of excavation 35 cubic yards.
- Shape basin to fit site with longest dimension oriented toward the longest inflow area.
- Install provisions for draining to prevent standing water problems.
- Clear the area of all debris.
- Grade the approach to the inlet uniformly.
- Drill weep holes into the side of the inlet.
- Protect weep holes with screen wire and washed aggregate.
- Seal weep holes when removing structure and stabilizing area.

- Build a temporary dike, if necessary, to the down slope side of the structure to prevent bypass flow.

Block and Gravel Filter - A barrier formed around the storm drain inlet with standard concrete blocks and gravel. See Figure 4.2.8.

- Provide a height of 1 to 2 feet above inlet.
- Recess the first row 2-inches into the ground for stability.
- Support subsequent courses by placing a 2x4 through the block opening.
- Do not use mortar.
- Lay some blocks in the bottom row on their side for dewatering the pool.
- Place hardware cloth or comparable wire mesh with ½-inch openings over all block openings.
- Place gravel just below the top of blocks on slopes of 2H:1V or flatter.
- An alternative design is a gravel donut.
- Provide an inlet slope of 3H:1V.
- Provide an outlet slope of 2H:1V.
- Provide a1-foot wide level stone area between the structure and the inlet.
- Use inlet slope stones 3 inches in diameter or larger.
- Use gravel ½- to ¾-inch at a minimum thickness of 1-foot for the outlet slope.

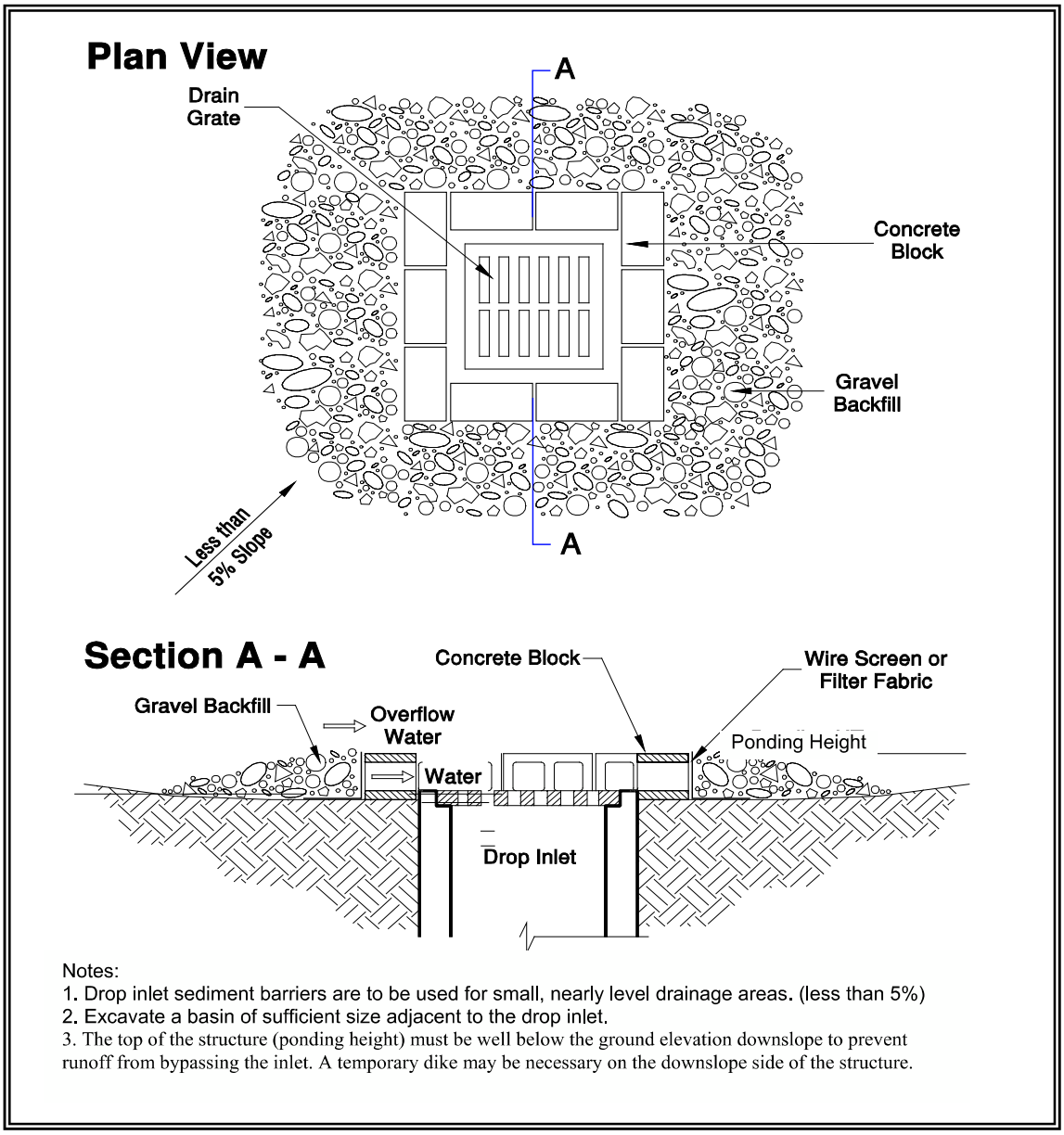


Figure 4.2.8 – Block and Gravel Filter

Gravel and Wire Mesh Filter - A gravel barrier placed over the top of the inlet. This structure does not provide an overflow.

- Use a hardware cloth or comparable wire mesh with ½-inch openings.
- Use coarse aggregate.
- Provide a height 1-foot or more, 18-inches wider than inlet on all sides.
- Place wire mesh over the drop inlet so that the wire extends a minimum of 1-foot beyond each side of the inlet structure.
- Overlap the strips if more than one strip of mesh is necessary.

- Place coarse aggregate over the wire mesh.
- Provide at least a 12-inch depth of gravel over the entire inlet opening and extend at least 18-inches on all sides.

Catchbasin Filters – Use inserts designed by manufacturers for construction sites. The limited sediment storage capacity increases the amount of inspection and maintenance required, which may be daily for heavy sediment loads. To reduce maintenance requirements combine a catchbasin filter with another type of inlet protection. This type of inlet protection provides flow bypass without overflow and therefore may be a better method for inlets located along active rights-of-way.

- Provides 5 cubic feet of storage.
- Requires dewatering provisions.
- Provides a high-flow bypass that will not clog under normal use at a construction site.
- Insert the catchbasin filter in the catchbasin just below the grating.

Curb Inlet Protection with Wooden Weir – Barrier formed around a curb inlet with a wooden frame and gravel.

- Use wire mesh with ½-inch openings.
- Use extra strength filter cloth.
- Construct a frame.
- Attach the wire and filter fabric to the frame.
- Pile coarse washed aggregate against wire/fabric.
- Place weight on frame anchors.

Block and Gravel Curb Inlet Protection – Barrier formed around a curb inlet with concrete blocks and gravel. See Figure 4.2.9.

- Use wire mesh with ½-inch openings.
- Place two concrete blocks on their sides abutting the curb at either side of the inlet opening. These are spacer blocks.
- Place a 2x4 stud through the outer holes of each spacer block to align the front blocks.
- Place blocks on their sides across the front of the inlet and abutting the spacer blocks.
- Place wire mesh over the outside vertical face.
- Pile coarse aggregate against the wire to the top of the barrier.

Curb and Gutter Sediment Barrier – Sandbag or rock berm (riprap and aggregate) 3 feet high and 3 feet wide in a horseshoe shape. See Figure 4.2.10.

- Construct a horseshoe shaped berm, faced with coarse aggregate if using riprap, 3 feet high and 3 feet wide, at least 2 feet from the inlet.
- Construct a horseshoe shaped sedimentation trap on the outside of the berm sized to sediment trap standards for protecting a culvert inlet.

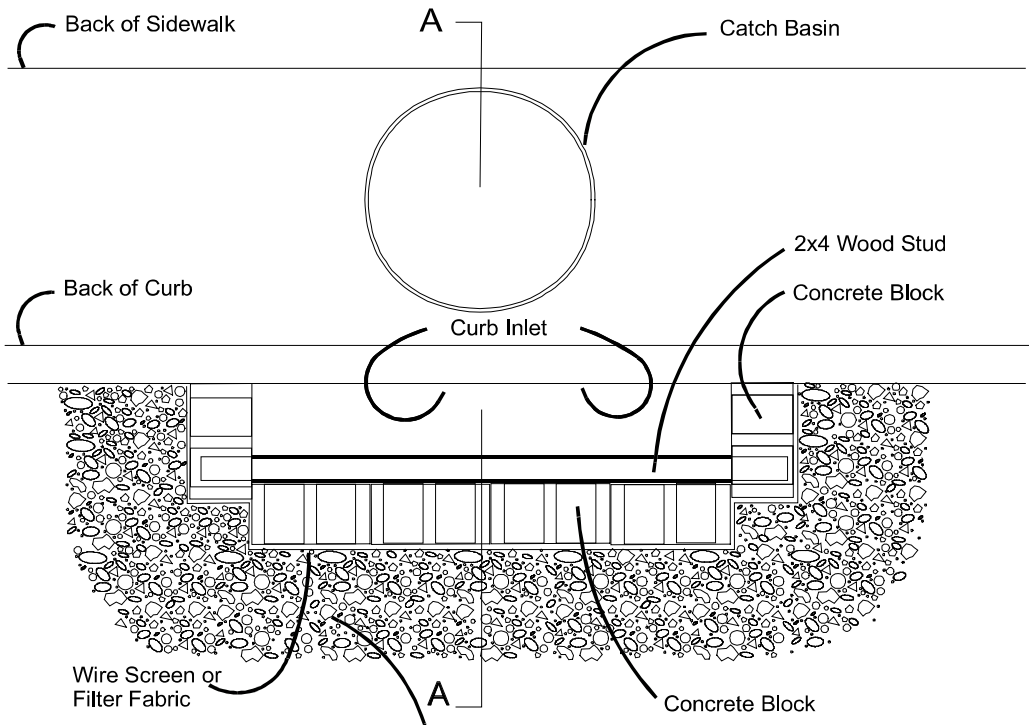
Maintenance Standards

- Inspect catch basin filters frequently, especially after storm events. Clean and replace clogged inserts. For systems with clogged stone filters: pull away the stones from the inlet and clean or replace. An alternative approach would be to use the clogged stone as fill and put fresh stone around the inlet.
- Do not wash sediment into storm drains while cleaning. Spread all excavated material evenly over the surrounding land area or stockpile and stabilize as appropriate.

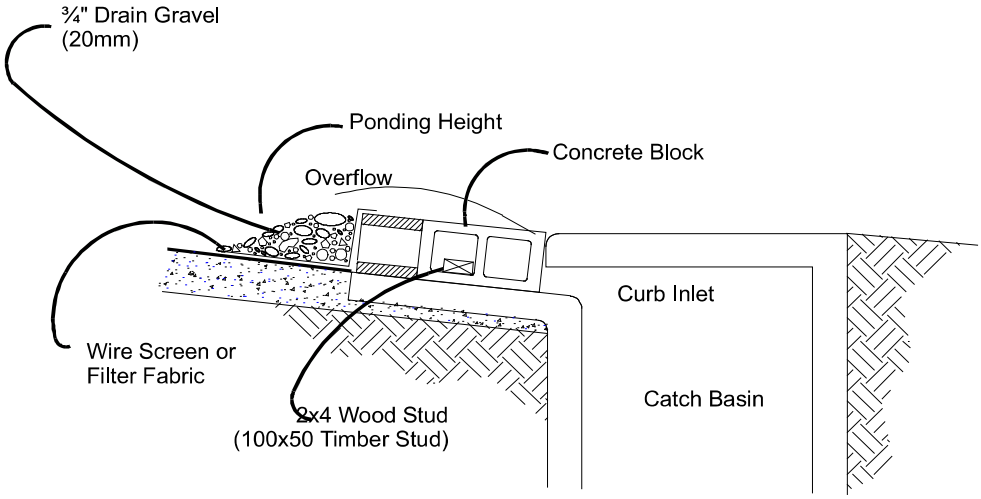
Approved as Equivalent

Ecology has approved products as able to meet the requirements of BMP C220. The products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. Local jurisdictions may choose not to accept this product approved as equivalent, or may require additional testing prior to consideration for local use. The products are available for review on Ecology's website at http://www.ecy.wa.gov/programs/wq/stormwater/newtech/equivalent.html

Plan View



Section A - A



NOTES:
1. Use block and gravel type sediment barrier when curb inlet is located in gently sloping street segment, where water can pond and allow sediment to separate from runoff.
2. Barrier shall allow for overflow from severe storm event.
3. Inspect barriers and remove sediment after each storm event. Sediment and gravel must be removed from the traveled way immediately.

Figure 4.2.9 – Block and Gravel Curb Inlet Protection

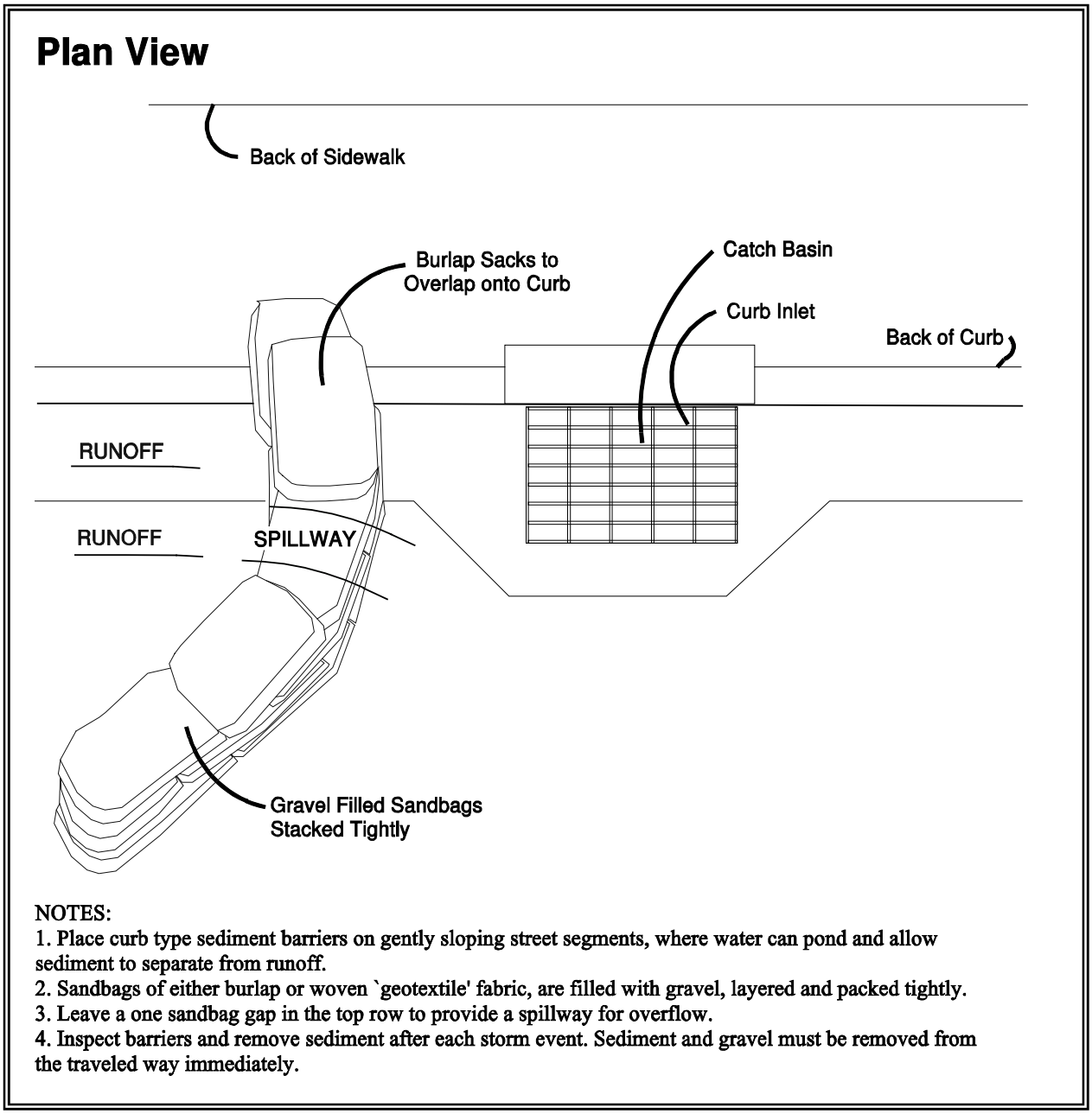


Figure 4.2.10 – Curb and Gutter Barrier

BMP C232: Gravel Filter Berm

Purpose

A gravel filter berm is constructed on rights-of-way or traffic areas within a construction site to retain sediment by using a filter berm of gravel or crushed rock.

Conditions of Use

Where a temporary measure is needed to retain sediment from rights-of-way or in traffic areas on construction sites.

Design and Installation Specifications

- Berm material shall be ¾ to 3 inches in size, washed well-grade gravel or crushed rock with less than 5 percent fines.
- Spacing of berms:
  - Every 300 feet on slopes less than 5 percent
  - Every 200 feet on slopes between 5 percent and 10 percent
  - Every 100 feet on slopes greater than 10 percent
- Berm dimensions:
  - 1 foot high with 3H:1V side slopes
  - 8 linear feet per 1 cfs runoff based on the 10-year, 24-hour design storm

Maintenance Standards

- Regular inspection is required. Sediment shall be removed and filter material replaced as needed.

BMP C233: Silt Fence

Purpose

Use of a silt fence reduces the transport of coarse sediment from a construction site by providing a temporary physical barrier to sediment and reducing the runoff velocities of overland flow. See Figure 4.2.12 for details on silt fence construction.

Conditions of Use

Silt fence may be used downslope of all disturbed areas.

- Silt fence shall prevent soil carried by runoff water from going beneath, through, or over the top of the silt fence, but shall allow the water to pass through the fence.
- Silt fence is not intended to treat concentrated flows, nor is it intended to treat substantial amounts of overland flow. Convey any concentrated flows through the drainage system to a sediment pond.
- Do not construct silt fences in streams or use in V-shaped ditches. Silt fences do not provide an adequate method of silt control for anything deeper than sheet or overland flow.

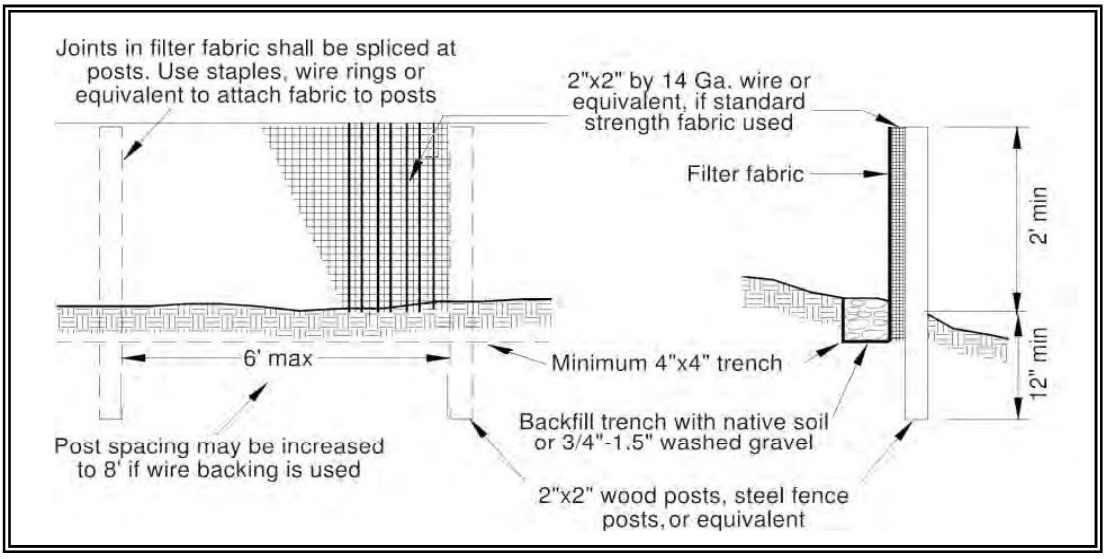


Figure 4.2.12 – Silt Fence

Design and Installation Specifications

- Use in combination with sediment basins or other BMPs.
- Maximum slope steepness (normal (perpendicular) to fence line) 1H:1V.
- Maximum sheet or overland flow path length to the fence of 100 feet.
- Do not allow flows greater than 0.5 cfs.
- The geotextile used shall meet the following standards. All geotextile properties listed below are minimum average roll values (i.e., the test result for any sampled roll in a lot shall meet or exceed the values shown in Table 4.2.3):

Table 4.2.3
Geotextile Standards

Polymeric Mesh AOS (ASTM D4751)	0.60 mm maximum for slit film woven (#30 sieve). 0.30 mm maximum for all other geotextile types (#50 sieve). 0.15 mm minimum for all fabric types (#100 sieve).
Water Permittivity (ASTM D4491)	0.02 sec^{-1} minimum
Grab Tensile Strength (ASTM D4632)	180 lbs. Minimum for extra strength fabric. 100 lbs minimum for standard strength fabric.
Grab Tensile Strength (ASTM D4632)	30% maximum
Ultraviolet Resistance (ASTM D4355)	70% minimum

- Support standard strength fabrics with wire mesh, chicken wire, 2-inch x 2-inch wire, safety fence, or jute mesh to increase the strength of the

fabric. Silt fence materials are available that have synthetic mesh backing attached.

- Filter fabric material shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of six months of expected usable construction life at a temperature range of 0°F. to 120°F.
- One-hundred percent biodegradable silt fence is available that is strong, long lasting, and can be left in place after the project is completed, if permitted by local regulations.
- Refer to Figure 4.2.12 for standard silt fence details. Include the following standard Notes for silt fence on construction plans and specifications:

  1. The contractor shall install and maintain temporary silt fences at the locations shown in the Plans.
  2. Construct silt fences in areas of clearing, grading, or drainage prior to starting those activities.
  3. The silt fence shall have a 2-feet min. and a 2½-feet max. height above the original ground surface.
  4. The filter fabric shall be sewn together at the point of manufacture to form filter fabric lengths as required. Locate all sewn seams at support posts. Alternatively, two sections of silt fence can be overlapped, provided the Contractor can demonstrate, to the satisfaction of the Engineer, that the overlap is long enough and that the adjacent fence sections are close enough together to prevent silt laden water from escaping through the fence at the overlap.
  5. Attach the filter fabric on the up-slope side of the posts and secure with staples, wire, or in accordance with the manufacturer's recommendations. Attach the filter fabric to the posts in a manner that reduces the potential for tearing.
  6. Support the filter fabric with wire or plastic mesh, dependent on the properties of the geotextile selected for use. If wire or plastic mesh is used, fasten the mesh securely to the up-slope side of the posts with the filter fabric up-slope of the mesh.
  7. Mesh support, if used, shall consist of steel wire with a maximum mesh spacing of 2-inches, or a prefabricated polymeric mesh. The strength of the wire or polymeric mesh shall be equivalent to or greater than 180 lbs. grab tensile strength. The polymeric mesh must be as resistant to the same level of ultraviolet radiation as the filter fabric it supports.
  8. Bury the bottom of the filter fabric 4-inches min. below the ground surface. Backfill and tamp soil in place over the buried portion of the filter fabric, so that no flow can pass beneath the fence and

scouring cannot occur. When wire or polymeric back-up support mesh is used, the wire or polymeric mesh shall extend into the ground 3-inches min.

9. Drive or place the fence posts into the ground 18-inches min. A 12–inch min. depth is allowed if topsoil or other soft subgrade soil is not present and 18-inches cannot be reached. Increase fence post min. depths by 6 inches if the fence is located on slopes of 3H:1V or steeper and the slope is perpendicular to the fence. If required post depths cannot be obtained, the posts shall be adequately secured by bracing or guying to prevent overturning of the fence due to sediment loading.
10. Use wood, steel or equivalent posts. The spacing of the support posts shall be a maximum of 6-feet. Posts shall consist of either:
    - Wood with dimensions of 2-inches by 2-inches wide min. and a 3-feet min. length. Wood posts shall be free of defects such as knots, splits, or gouges.
    - No. 6 steel rebar or larger.
    - ASTM A 120 steel pipe with a minimum diameter of 1-inch.
    - U, T, L, or C shape steel posts with a minimum weight of 1.35 lbs./ft.
    - Other steel posts having equivalent strength and bending resistance to the post sizes listed above.
11. Locate silt fences on contour as much as possible, except at the ends of the fence, where the fence shall be turned uphill such that the silt fence captures the runoff water and prevents water from flowing around the end of the fence.
12. If the fence must cross contours, with the exception of the ends of the fence, place gravel check dams perpendicular to the back of the fence to minimize concentrated flow and erosion. The slope of the fence line where contours must be crossed shall not be steeper than 3H:1V.
    - Gravel check dams shall be approximately 1-foot deep at the back of the fence. Gravel check dams shall be continued perpendicular to the fence at the same elevation until the top of the check dam intercepts the ground surface behind the fence.
    - Gravel check dams shall consist of crushed surfacing base course, gravel backfill for walls, or shoulder ballast. Gravel check dams shall be located every 10 feet along the fence where the fence must cross contours.

- Refer to Figure 4.2.13 for slicing method details. Silt fence installation using the slicing method specifications:

1. The base of both end posts must be at least 2- to 4-inches above the top of the filter fabric on the middle posts for ditch checks to drain properly. Use a hand level or string level, if necessary, to mark base points before installation.
2. Install posts 3- to 4-feet apart in critical retention areas and 6- to 7-feet apart in standard applications.
3. Install posts 24-inches deep on the downstream side of the silt fence, and as close as possible to the filter fabric, enabling posts to support the filter fabric from upstream water pressure.
4. Install posts with the nipples facing away from the filter fabric.
5. Attach the filter fabric to each post with three ties, all spaced within the top 8-inches of the filter fabric. Attach each tie diagonally 45 degrees through the filter fabric, with each puncture at least 1-inch vertically apart. Each tie should be positioned to hang on a post nipple when tightening to prevent sagging.
6. Wrap approximately 6-inches of fabric around the end posts and secure with 3 ties.
7. No more than 24-inches of a 36-inch filter fabric is allowed above ground level.

   Compact the soil immediately next to the filter fabric with the front wheel of the tractor, skid steer, or roller exerting at least 60 pounds per square inch. Compact the upstream side first and then each side twice for a total of four trips. Check and correct the silt fence installation for any deviation before compaction. Use a flat-bladed shovel to tuck fabric deeper into the ground if necessary.

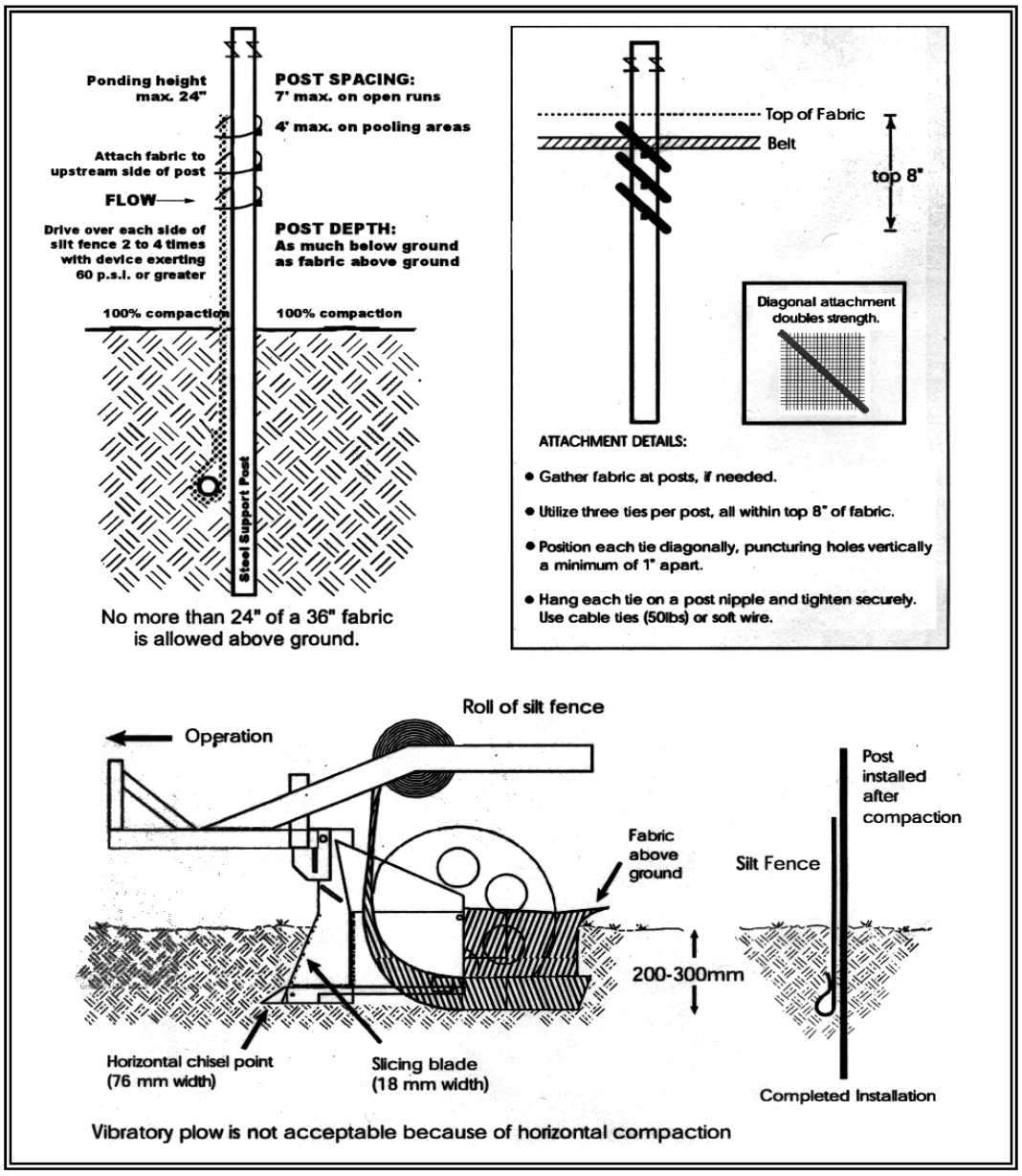


Figure 4.2.13 – Silt Fence Installation by Slicing Method

Maintenance Standards

- Repair any damage immediately.
- Intercept and convey all evident concentrated flows uphill of the silt fence to a sediment pond.
- Check the uphill side of the fence for signs of the fence clogging and acting as a barrier to flow and then causing channelization of flows parallel to the fence. If this occurs, replace the fence or remove the trapped sediment.

- Remove sediment deposits when the deposit reaches approximately one-third the height of the silt fence, or install a second silt fence.
- Replace filter fabric that has deteriorated due to ultraviolet breakdown.

BMP C234: Vegetated Strip

Purpose

Vegetated strips reduce the transport of coarse sediment from a construction site by providing a temporary physical barrier to sediment and reducing the runoff velocities of overland flow.

Conditions of Use

- Vegetated strips may be used downslope of all disturbed areas.
- Vegetated strips are not intended to treat concentrated flows, nor are they intended to treat substantial amounts of overland flow. Any concentrated flows must be conveyed through the drainage system to a sediment pond. The only circumstance in which overland flow can be treated solely by a strip, rather than by a sediment pond, is when the following criteria are met (see Table 4.2.4):

Table 4.2.4
Contributing Drainage Area for Vegetated Strips

Average Contributing area Slope	Average Contributing area Percent Slope	Max Contributing area Flowpath Length
1.5H:1V or flatter	67% or flatter	100 feet
2H:1V or flatter	50% or flatter	115 feet
4H:1V or flatter	25% or flatter	150 feet
6H:1V or flatter	16.7% or flatter	200 feet
10H:1V or flatter	10% or flatter	250 feet

Design and Installation Specifications

- The vegetated strip shall consist of a minimum of a 25-foot flowpath length continuous strip of dense vegetation with topsoil. Grass-covered, landscaped areas are generally not adequate because the volume of sediment overwhelms the grass. Ideally, vegetated strips shall consist of undisturbed native growth with a well-developed soil that allows for infiltration of runoff.
- The slope within the strip shall not exceed 4H:1V.
- The uphill boundary of the vegetated strip shall be delineated with clearing limits.

Maintenance Standards

- Any areas damaged by erosion or construction activity shall be seeded immediately and protected by mulch.
- If more than 5 feet of the original vegetated strip width has had vegetation removed or is being eroded, sod must be installed.
- If there are indications that concentrated flows are traveling across the buffer, surface water controls must be installed to reduce the flows

entering the buffer, or additional perimeter protection must be installed.

BMP C235: Wattles

Purpose

Wattles are temporary erosion and sediment control barriers consisting of straw, compost, or other material that is wrapped in biodegradable tubular plastic or similar encasing material. They reduce the velocity and can spread the flow of rill and sheet runoff, and can capture and retain sediment. Wattles are typically 8 to 10 inches in diameter and 25 to 30 feet in length. Wattles are placed in shallow trenches and staked along the contour of disturbed or newly constructed slopes. See Figure 4.2.14 for typical construction details. WSDOT Standard Plan I-30.30-00 also provides information on Wattles (http://www.wsdot.wa.gov/Design/Standards/Plans.htm#SectionI)

Conditions of Use

- Use wattles:
  - In disturbed areas that require immediate erosion protection.
  - On exposed soils during the period of short construction delays, or over winter months.
  - On slopes requiring stabilization until permanent vegetation can be established.
- The material used dictates the effectiveness period of the wattle. Generally, Wattles are typically effective for one to two seasons.
- Prevent rilling beneath wattles by properly entrenching and abutting wattles together to prevent water from passing between them.

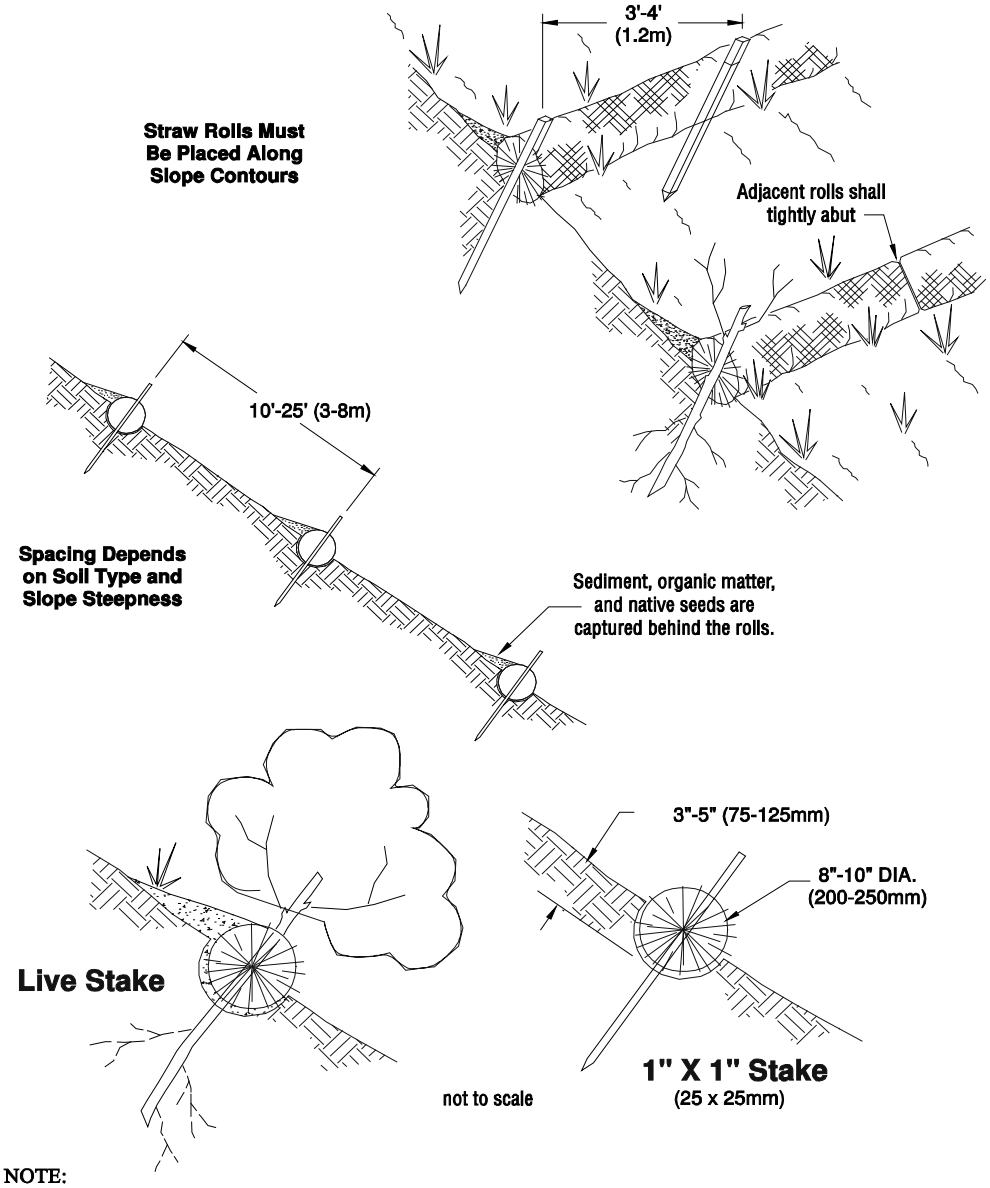
Design Criteria

- Install wattles perpendicular to the flow direction and parallel to the slope contour.
- Narrow trenches should be dug across the slope on contour to a depth of 3- to 5-inches on clay soils and soils with gradual slopes. On loose soils, steep slopes, and areas with high rainfall, the trenches should be dug to a depth of 5- to 7- inches, or 1/2 to 2/3 of the thickness of the wattle.
- Start building trenches and installing wattles from the base of the slope and work up. Spread excavated material evenly along the uphill slope and compacted using hand tamping or other methods.
- Construct trenches at intervals of 10- to 25-feet depending on the steepness of the slope, soil type, and rainfall. The steeper the slope the closer together the trenches.
- Install the wattles snugly into the trenches and abut tightly end to end. Do not overlap the ends.
- Install stakes at each end of the wattle, and at 4-foot centers along entire length of wattle.

- If required, install pilot holes for the stakes using a straight bar to drive holes through the wattle and into the soil.
- Wooden stakes should be approximately 3/4 x 3/4 x 24 inches min. Willow cuttings or 3/8-inch rebar can also be used for stakes.
- Stakes should be driven through the middle of the wattle, leaving 2 to 3 inches of the stake protruding above the wattle.

Maintenance Standards

- Wattles may require maintenance to ensure they are in contact with soil and thoroughly entrenched, especially after significant rainfall on steep sandy soils.



NOTE:
1. Straw roll installation requires the placement and secure staking of the roll in a trench, 3"-5" (75-125mm) deep, dug on contour. runoff must not be allowed to run under or around roll.

Figure 4.2.14 – Wattles

- Inspect the slope after significant storms and repair any areas where wattles are not tightly abutted or water has scoured beneath the wattles.

Approved as Equivalent

Ecology has approved products as able to meet the requirements of BMP C235. The products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. Local jurisdictions may choose not to accept this product approved as equivalent, or may require additional testing prior to consideration for local use. The products are available for review on Ecology's website at http://www.ecy.wa.gov/programs/wq/stormwater/newtech/equivalent.html

BMP C236: Vegetative Filtration

Purpose

Vegetative Filtration may be used in conjunction with BMP C241 Temporary Sediment Ponds, BMP C206 Level Spreader and a pumping system with surface intake to improve turbidity levels of stormwater discharges by filtering through existing vegetation where undisturbed forest floor duff layer or established lawn with thatch layer are present. Vegetative Filtration can also be used to infiltrate dewatering waste from foundations, vaults, and trenches as long as runoff does not occur.

Conditions of Use

- For every five acre of disturbed soil use one acre of grass field, farm pasture, or wooded area. Reduce or increase this area depending on project size, ground water table height, and other site conditions.
- Wetlands shall not be used for filtration.
- Do not use this BMP in areas with a high ground water table, or in areas that will have a high seasonal ground water table during the use of this BMP.
- This BMP may be less effective on soils that prevent the infiltration of the water, such as hard till.
- Using other effective source control measures throughout a construction site will prevent the generation of additional highly turbid water and may reduce the time period or area need for this BMP.
- Stop distributing water into the vegetated area if standing water or erosion results.

Design Criteria

- Find land adjacent to the project that has a vegetated field, preferably a farm field, or wooded area.
- If the project site does not contain enough vegetated field area consider obtaining permission from adjacent landowners (especially for farm fields).
- Install a pump and downstream distribution manifold depending on the project size. Generally, the main distribution line should reach 100 to 200-feet long (many large projects, or projects on tight soil, will

Appendix C – Alternative BMPs

The following includes a list of possible alternative BMPs for each of the 12 elements not described in the main SWPPP text. This list can be referenced in the event a BMP for a specific element is not functioning as designed and an alternative BMP needs to be implemented.

Element #1 - Mark Clearing Limits

Not Used

Element #2 - Establish Construction Access

BMP C106: Wheel Wash

Element #3 - Control Flow Rates

BMP C235: Straw Wattles

Element #4 - Install Sediment Controls

BMP C240: Sediment Trap

Element #5 - Stabilize Soils

BMP C121: Mulching
BMP C122: Nets and Blankets
BMP C125: Topsoiling

Element #6 - Protect Slopes

Not Used

Element #8 - Stabilize Channels and Outlets

Not Used

Element #10 - Control Dewatering

Not Used

Appendix D – General Permit

Appendix E – Site Inspection Forms (and Site Log)

The results of each inspection shall be summarized in an inspection report or checklist that is entered into or attached to the site log book. It is suggested that the inspection report or checklist be included in this appendix to keep monitoring and inspection information in one document, but this is optional. However, it is mandatory that this SWPPP and the site inspection forms be kept onsite at all times during construction, and that inspections be performed and documented as outlined below.

At a minimum, each inspection report or checklist shall include:

a. Inspection date/times

b. Weather information: general conditions during inspection, approximate amount of precipitation since the last inspection, and approximate amount of precipitation within the last 24 hours.

c. A summary or list of all BMPs that have been implemented, including observations of all erosion/sediment control structures or practices.

d. The following shall be noted:

   i. locations of BMPs inspected,

   ii. locations of BMPs that need maintenance,

   iii. the reason maintenance is needed,

   iv. locations of BMPs that failed to operate as designed or intended, and

   v. locations where additional or different BMPs are needed, and the reason(s) why

e. A description of stormwater discharged from the site. The presence of suspended sediment, turbid water, discoloration, and/or oil sheen shall be noted, as applicable.

f. A description of any water quality monitoring performed during inspection, and the results of that monitoring.

g. General comments and notes, including a brief description of any BMP repairs, maintenance or installations made as a result of the inspection.

h. A statement that, in the judgment of the person conducting the site inspection, the site is either in compliance or out of compliance with the terms and conditions of the SWPPP and the NPDES

permit. If the site inspection indicates that the site is out of compliance, the inspection report shall include a summary of the remedial actions required to bring the site back into compliance, as well as a schedule of implementation.

i. Name, title, and signature of person conducting the site inspection; and the following statement: "I certify under penalty of law that this report is true, accurate, and complete, to the best of my knowledge and belief".

When the site inspection indicates that the site is not in compliance with any terms and conditions of the NPDES permit, the Permittee shall take immediate action(s) to: stop, contain, and clean up the unauthorized discharges, or otherwise stop the noncompliance; correct the problem(s); implement appropriate Best Management Practices (BMPs), and/or conduct maintenance of existing BMPs; and achieve compliance with all applicable standards and permit conditions. In addition, if the noncompliance causes a threat to human health or the environment, the Permittee shall comply with the Noncompliance Notification requirements in Special Condition S5.F of the permit.

Site Inspection Form

General Information			
Project Name:			
Inspector Name:		**Title:** **CESCL # :**	
Date:		**Time:**	
Inspection Type:	□ After a rain event □ Weekly □ Turbidity/transparency benchmark exceedance □ Other		
Weather			
Precipitation	Since last inspection	In last 24 hours	
Description of General Site Conditions:			

Inspection of BMPs

Element 1: Mark Clearing Limits

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

Element 2: Establish Construction Access

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

Element 3: Control Flow Rates

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

Element 4: Install Sediment Controls

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

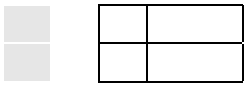
Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	



Element 5: Stabilize Soils

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

Element 6: Protect Slopes

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

Element 7: Protect Drain Inlets							
BMP:							
Location	Inspected			Functioning			Problem/Corrective Action
	Y	N		Y	N	NIP	
BMP:							
Location	Inspected			Functioning			Problem/Corrective Action
	Y	N		Y	N	NIP	
BMP:							
Location	Inspected			Functioning			Problem/Corrective Action
	Y	N		Y	N	NIP	
Element 8: Stabilize Channels and Outlets							
BMP:							
Location	Inspected			Functioning			Problem/Corrective Action
	Y	N		Y	N	NIP	
BMP:							
Location	Inspected			Functioning			Problem/Corrective Action
	Y	N		Y	N	NIP	
BMP:							
Location	Inspected			Functioning			Problem/Corrective Action
	Y	N		Y	N	NIP	
BMP:							
Location	Inspected			Functioning			Problem/Corrective Action
	Y	N		Y	N	NIP	

Element 9: Control Pollutants								
BMP:								
Location	Inspected			Functioning			Problem/Corrective Action	
	Y	N		Y	N	NIP		
BMP:								
Location	Inspected			Functioning			Problem/Corrective Action	
	Y	N		Y	N	NIP		

Element 10: Control Dewatering								
BMP:								
Location	Inspected			Functioning			Problem/Corrective Action	
	Y	N		Y	N	NIP		
BMP:								
Location	Inspected			Functioning			Problem/Corrective Action	
	Y	N		Y	N	NIP		
BMP:								
Location	Inspected			Functioning			Problem/Corrective Action	
	Y	N		Y	N	NIP		

Stormwater Discharges From the Site			
	Observed?		Problem/Corrective Action
	Y	N	
Location			
Turbidity			
Discoloration			
Sheen			
Location			
Turbidity			
Discoloration			
Sheen			

Water Quality Monitoring
Was any water quality monitoring conducted? □ Yes □ No If water quality monitoring was conducted, record results here:
If water quality monitoring indicated turbidity 250 NTU or greater; or transparency 6 cm or less, was Ecology notified by phone within 24 hrs? □ Yes □ No
If Ecology was notified, indicate the date, time, contact name and phone number below: Date: Time: Contact Name: Phone #:
General Comments and Notes Include BMP repairs, maintenance, or installations made as a result of the inspection.
Were Photos Taken? □ Yes □ No If photos taken, describe photos below:

APPENDIX D

OPERATIONS AND MAINTENANCE MANUAL

No. 2 – Infiltration

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Trash & Debris	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Poisonous/Noxious Vegetation	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Contaminants and Pollution	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Rodent Holes	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1)
Storage Area	Sediment	Water ponding in infiltration pond after rainfall ceases and appropriate time allowed for infiltration. Treatment basins should infiltrate Water Quality Design Storm Volume within 48 hours, and empty within 24 hours after cessation of most rain events. (A percolation test pit or test of facility indicates facility is only working at 90% of its designed capabilities. Test every 2 to 5 years. If two inches or more sediment is present, remove).	Sediment is removed and/or facility is cleaned so that infiltration system works according to design.
Filter Bags (if applicable)	Filled with Sediment and Debris	Sediment and debris fill bag more than 1/2 full.	Filter bag is replaced or system is redesigned.
Rock Filters	Sediment and Debris	By visual inspection, little or no water flows through filter during heavy rain storms.	Gravel in rock filter is replaced.
Side Slopes of Pond	Erosion	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
Emergency Overflow Spillway and Berms over 4 feet in height.	Tree Growth	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Piping	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
Emergency Overflow Spillway	Rock Missing	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Erosion	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
Pre-settling Ponds and Vaults	Facility or sump filled with Sediment and/or debris	6" or designed sediment trap depth of sediment.	Sediment is removed.

No. 3 – Closed Detention Systems (Tanks/Vaults)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
Storage Area	Plugged Air Vents	One-half of the cross section of a vent is blocked at any point or the vent is damaged.	Vents open and functioning.
	Debris and Sediment	Accumulated sediment depth exceeds 10% of the diameter of the storage area for 1/2 length of storage vault or any point depth exceeds 15% of diameter. (Example: 72-inch storage tank would require cleaning when sediment reaches depth of 7 inches for more than 1/2 length of tank.)	All sediment and debris removed from storage area.
	Joints Between Tank/Pipe Section	Any openings or voids allowing material to be transported into facility. (Will require engineering analysis to determine structural stability).	All joint between tank/pipe sections are sealed.
	Tank Pipe Bent Out of Shape	Any part of tank/pipe is bent out of shape more than 10% of its design shape. (Review required by engineer to determine structural stability).	Tank/pipe repaired or replaced to design.
	Vault Structure Includes Cracks in Wall, Bottom, Damage to Frame and/or Top Slab	Cracks wider than 1/2-inch and any evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determines that the vault is not structurally sound. Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or any evidence of soil particles entering the vault through the walls.	Vault replaced or repaired to design specifications and is structurally sound. No cracks more than 1/4-inch wide at the joint of the inlet/outlet pipe.
Manhole	Cover Not in Place	Cover is missing or only partially in place. Any open manhole requires maintenance.	Manhole is closed.
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread (may not apply to self-locking lids).	Mechanism opens with proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. Intent is to keep cover from sealing off access to maintenance.	Cover can be removed and reinstalled by one maintenance person.
	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, misalignment, not securely attached to structure wall, rust, or cracks.	Ladder meets design standards. Allows maintenance person safe access.
Catch Basins	See “Catch Basins” (No. 5)	See “Catch Basins” (No. 5).	See “Catch Basins” (No. 5).

No. 5 – Catch Basins

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
General	Trash & Debris	Trash or debris which is located immediately in front of the catch basin opening or is blocking inletting capacity of the basin by more than 10%.	No Trash or debris located immediately in front of catch basin or on grate opening.
		Trash or debris (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of six inches clearance from the debris surface to the invert of the lowest pipe.	No trash or debris in the catch basin.
		Trash or debris in any inlet or outlet pipe blocking more than 1/3 of its height.	Inlet and outlet pipes free of trash or debris.
		Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).	No dead animals or vegetation present within the catch basin.
	Sediment	Sediment (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches clearance from the sediment surface to the invert of the lowest pipe.	No sediment in the catch basin
	Structure Damage to Frame and/or Top Slab	Top slab has holes larger than 2 square inches or cracks wider than 1/4 inch (Intent is to make sure no material is running into basin).	Top slab is free of holes and cracks.
		Frame not sitting flush on top slab, i.e., separation of more than 3/4 inch of the frame from the top slab. Frame not securely attached	Frame is sitting flush on the riser rings or top slab and firmly attached.
	Fractures or Cracks in Basin Walls/ Bottom	Maintenance person judges that structure is unsound.	Basin replaced or repaired to design standards.
		Grout fillet has separated or cracked wider than 1/2 inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks.	Pipe is regrouted and secure at basin wall.
	Settlement/ Misalignment	If failure of basin has created a safety, function, or design problem.	Basin replaced or repaired to design standards.
	Vegetation	Vegetation growing across and blocking more than 10% of the basin opening.	No vegetation blocking opening to basin.
		Vegetation growing in inlet/outlet pipe joints that is more than six inches tall and less than six inches apart.	No vegetation or root growth present.
	Contamination and Pollution	See "Detention Ponds" (No. 1).	No pollution present.

No. 5 – Catch Basins

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
Catch Basin Cover	Cover Not in Place	Cover is missing or only partially in place. Any open catch basin requires maintenance.	Catch basin cover is closed
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread.	Mechanism opens with proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. (Intent is keep cover from sealing off access to maintenance.)	Cover can be removed by one maintenance person.
Ladder	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, not securely attached to basin wall, misalignment, rust, cracks, or sharp edges.	Ladder meets design standards and allows maintenance person safe access.
Metal Grates (If Applicable)	Grate opening Unsafe	Grate with opening wider than 7/8 inch.	Grate opening meets design standards.
	Trash and Debris	Trash and debris that is blocking more than 20% of grate surface inletting capacity.	Grate free of trash and debris.
	Damaged or Missing.	Grate missing or broken member(s) of the grate.	Grate is in place and meets design standards.

No. 6 – Debris Barriers (e.g., Trash Racks)

Maintenance Components	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and Debris	Trash or debris that is plugging more than 20% of the openings in the barrier.	Barrier cleared to design flow capacity.
Metal	Damaged/ Missing Bars.	Bars are bent out of shape more than 3 inches.	Bars in place with no bends more than 3/4 inch.
		Bars are missing or entire barrier missing.	Bars in place according to design.
		Bars are loose and rust is causing 50% deterioration to any part of barrier.	Barrier replaced or repaired to design standards.
	Inlet/Outlet Pipe	Debris barrier missing or not attached to pipe	Barrier firmly attached to pipe

No. 8 – Typical Biofiltration Swale

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Sediment Accumulation on Grass	Sediment depth exceeds 2 inches.	Remove sediment deposits on grass treatment area of the bio-swale. When finished, swale should be level from side to side and drain freely toward outlet. There should be no areas of standing water once inflow has ceased.
	Standing Water	When water stands in the swale between storms and does not drain freely.	Any of the following may apply: remove sediment or trash blockages, improve grade from head to foot of swale, remove clogged check dams, add underdrains or convert to a wet biofiltration swale.
	Flow spreader	Flow spreader uneven or clogged so that flows are not uniformly distributed through entire swale width.	Level the spreader and clean so that flows are spread evenly over entire swale width.
	Constant Baseflow	When small quantities of water continually flow through the swale, even when it has been dry for weeks, and an eroded, muddy channel has formed in the swale bottom.	Add a low-flow pea-gravel drain the length of the swale or by-pass the baseflow around the swale.
	Poor Vegetation Coverage	When grass is sparse or bare or eroded patches occur in more than 10% of the swale bottom.	Determine why grass growth is poor and correct that condition. Re-plant with plugs of grass from the upper slope: plant in the swale bottom at 8-inch intervals. Or re-seed into loosened, fertile soil.
	Vegetation	When the grass becomes excessively tall (greater than 10-inches); when nuisance weeds and other vegetation starts to take over.	Mow vegetation or remove nuisance vegetation so that flow not impeded. Grass should be mowed to a height of 3 to 4 inches. Remove grass clippings.
	Excessive Shading	Grass growth is poor because sunlight does not reach swale.	If possible, trim back over-hanging limbs and remove brushy vegetation on adjacent slopes.
	Inlet/Outlet	Inlet/outlet areas clogged with sediment and/or debris.	Remove material so that there is no clogging or blockage in the inlet and outlet area.
	Trash and Debris Accumulation	Trash and debris accumulated in the bio-swale.	Remove trash and debris from bioswale.
	Erosion/Scouring	Eroded or scoured swale bottom due to flow channelization, or higher flows.	For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with crushed gravel. If bare areas are large, generally greater than 12 inches wide, the swale should be re-graded and re-seeded. For smaller bare areas, overseed when bare spots are evident, or take plugs of grass from the upper slope and plant in the swale bottom at 8-inch intervals.

No. 9 – Wet Biofiltration Swale

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Sediment Accumulation	Sediment depth exceeds 2-inches in 10% of the swale treatment area.	Remove sediment deposits in treatment area.
	Water Depth	Water not retained to a depth of about 4 inches during the wet season.	Build up or repair outlet berm so that water is retained in the wet swale.
	Wetland Vegetation	Vegetation becomes sparse and does not provide adequate filtration, OR vegetation is crowded out by very dense clumps of cattail, which do not allow water to flow through the clumps.	Determine cause of lack of vigor of vegetation and correct. Replant as needed. For excessive cattail growth, cut cattail shoots back and compost off-site. Note: normally wetland vegetation does not need to be harvested unless die-back is causing oxygen depletion in downstream waters.
	Inlet/Outlet	Inlet/outlet area clogged with sediment and/or debris.	Remove clogging or blockage in the inlet and outlet areas.
	Trash and Debris Accumulation	See "Detention Ponds" (No. 1).	Remove trash and debris from wet swale.
	Erosion/Scouring	Swale has eroded or scoured due to flow channelization, or higher flows.	Check design flows to assure swale is large enough to handle flows. By-pass excess flows or enlarge swale. Replant eroded areas with fibrous-rooted plants such as Juncus effusus (soft rush) in wet areas or snowberry (Symphoricarpos albus) in dryer areas.

No. 21 - Maintenance Standards and Procedures for Bioretention Facilities.

Note that the inspection and routine maintenance frequencies listed below are recommended by Ecology. They do not supersede or replace the municipal stormwater permit requirements for inspection frequency required of municipal stormwater permittees for "stormwater treatment and flow control BMPs/facilities."

Maintenance Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Facility Footprint				
Earthen side slopes and berms	B, S		Erosion (gullies/ rills) greater than 2 inches deep around inlets, outlet, and alongside slopes	• Eliminate cause of erosion and stabilize damaged area (regrade, rock, vegetation, erosion control matting) • For deep channels or cuts (over 3 inches in ponding depth), temporary erosion control measures should be put in place until permanent repairs can be made. • Properly designed, constructed and established facilities with appropriate flow velocities should not have erosion problems except perhaps in extreme events. If erosion problems persist, the following should be reassessed: (1) flow volumes from contributing areas and bioretention facility sizing; (2) flow velocities and gradients within the facility; and (3) flow dissipation and erosion protection strategies at the facility inlet.
	A		Erosion of sides causes slope to become a hazard	Take actions to eliminate the hazard and stabilize slopes
	A, S		Settlement greater than 3 inches (relative to undisturbed sections of berm)	Restore to design height
	A, S		Downstream face of berm wet, seeps or leaks evident	Plug any holes and compact berm (may require consultation with engineer, particularly for larger berms)
	A		Any evidence of rodent holes or water piping in berm	• Eradicate rodents (see "Pest control") • Fill holes and compact (may require consultation with engineer, particularly for larger berms)
Concrete sidewalls	A		Cracks or failure of concrete sidewalls	• Repair/ seal cracks • Replace if repair is insufficient
Rockery sidewalls	A		Rockery side walls are insecure	Stabilize rockery sidewalls (may require consultation with engineer, particularly for walls 4 feet or greater in height)
Facility area		All maintenance visits (at least biannually)	Trash and debris present	Clean out trash and debris
Facility bottom area	A, S		Accumulated sediment to extent that infiltration rate is reduced (see "Ponded water") or surface storage capacity significantly impacted	• Remove excess sediment • Replace any vegetation damaged or destroyed by sediment accumulation and removal • Mulch newly planted vegetation • Identify and control the sediment source (if feasible) • If accumulated sediment is recurrent, consider adding presettlement or installing berms to create a forebay at the inlet
		During/after fall leaf drop	Accumulated leaves in facility	Remove leaves if there is a risk to clogging outlet structure or water flow is impeded
Low permeability check dams and weirs	A, S		Sediment, vegetation, or debris accumulated at or blocking (or having the potential to block) check dam, flow control weir or orifice	Clear the blockage
	A, S		Erosion and/or undercutting present	Repair and take preventative measures to prevent future erosion and/or undercutting
	A		Grade board or top of weir damaged or not level	Restore to level position

[a] Frequency: A = Annually; B = Biannually (twice per year); M = Monthly; W = At least one visit should occur during the wet season (for debris/clog related maintenance, this inspection/maintenance visit should occur in the early fall, after deciduous trees have lost their leaves); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).

IPM – Integrated Pest Management

ISA – International Society of Arboriculture

No. 21 (continued) - Maintenance Standards and Procedures for Bioretention Facilities.

Maintenance Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Facility Footprint (cont'd)				
Ponded water	B, S		Excessive ponding water: Water overflows during storms smaller than the design event or ponded water remains in the basin 48 hours or longer after the end of a storm.	Determine cause and resolve in the following order: 1) Confirm leaf or debris buildup in the bottom of the facility is not impeding infiltration. If necessary, remove leaf litter/debris. 2) Ensure that underdrain (if present) is not clogged. If necessary, clear underdrain. 3) Check for other water inputs (e.g., groundwater, illicit connections). 4) Verify that the facility is sized appropriately for the contributing area. Confirm that the contributing area has not increas ed. If steps #1-4 do not solve the problem, the bioretention soil is likely clogged by sediment accumulation at the surface or has become overly compacted. Dig a small hole to observe soil profile and identify compaction depth or clogging front to help determine the soil depth to be removed or otherwise rehabilitated (e.g., tilled). Consultation with an engineer is recommended.
Bioretention soil media	As needed		Bioretention soil media protection is needed when performing maintenance requiring entrance into the facility footprint	• Minimize all loading in the facility footprint (foot traffic and other loads) to the degree feasible in order to prevent compaction of bioretention soils. • Never drive equipment or apply heavy loads in facility footprint. • Because the risk of compaction is higher during saturated soil conditions, any type of loading in the cell (including foot traffic) should be minimized during wet conditions. • Consider measures to distribute loading if heavy foot traffic is required or equipment must be placed in facility. As an example, boards may be placed across soil to distribute loads and minimize compaction. • If compaction occurs, soil must be loosened or otherwise rehabilitated to original design state.
Inlets/Outlets/Pipes				
Splash block inlet	A		Water is not being directed properly to the facility and away from the inlet structure	Reconfigure/ repair blocks to direct water to facility and away from structure
Curb cut inlet/outlet	M during the wet season and before severe storm is forecasted	Weekly during fall leaf drop	Accumulated leaves at curb cuts	Clear leaves (particularly important for key inlets and low points along long, linear facilities)
Pipe inlet/outlet	A		Pipe is damaged	Repair/ replace
	W		Pipe is clogged	Remove roots or debris
	A, S		Sediment, debris, trash, or mulch reducing capacity of inlet/outlet	• Clear the blockage • Identify the source of the blockage and take actions to prevent future blockages
		Weekly during fall leaf drop	Accumulated leaves at inlets/outlets	Clear leaves (particularly important for key inlets and low points along long, linear facilities)
		A	Maintain access for inspections	• Clear vegetation (transplant vegetation when possible) within 1 foot of inlets and outlets, maintain access pathways • Consultation with a landscape architect is recommended for removal, transplant, or substitution of plants
Erosion control at inlet	A		Concentrated flows are causing erosion	Maintain a cover of rock or cobbles or other erosion protection measure (e.g., matting) to protect the ground where concentrated water enters the facility (e.g., a pipe, curb cut or swale)

No. 21 (continued) - Maintenance Standards and Procedures for Bioretention Facilities.

Maintenance Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Inlets/Outlets/Pipes (cont'd)				
Trash rack	S		Trash or other debris present on trash rack	Remove/dispose
	A		Bar screen damaged or missing	Repair/replace
Overflow	A, S		Capacity reduced by sediment or debris	Remove sediment or debris/dispose
Underdrain pipe	Clean pipe as needed	Clean orifice at least biannually (may need more frequent cleaning during wet season)	• Plant roots, sediment or debris reducing capacity of underdrain • Prolonged surface ponding (see "Ponded water")	• Jet clean or rotary cut debris/roots from underdrain(s) • If underdrains are equipped with a flow restrictor (e.g., orifice) to attenuate flows, the orifice must be cleaned regularly.
Vegetation				
Facility bottom area and upland slope vegetation	Fall and Spring		Vegetation survival rate falls below 75% within first two years of establishment (unless project O&M manual or record drawing stipulates more or less than 75% survival rate).	• Determine cause of poor vegetation growth and correct condition • Replant as necessary to obtain 75% survival rate or greater. Refer to original planting plan, or approved jurisdictional species list for appropriate plant replacements (See Appendix 3 - Bioretention Plant List, in the LID Technical Guidance Manual for Puget Sound). • Confirm that plant selection is appropriate for site growing conditions • Consultation with a landscape architect is recommended for removal, transplant, or substitution of plants
Vegetation (general)	As needed		Presence of diseased plants and plant material	• Remove any diseased plants or plant parts and dispose of in an approved location (e.g., commercial landfill) to avoid risk of spreading the disease to other plants • Disinfect gardening tools after pruning to prevent the spread of disease • See Pacific Northwest Plant Disease Management Handbook for information on disease recognition and for additional resources • Replant as necessary according to recommendations provided for "facility bottom area and upland slope vegetation".
Trees and shrubs		All pruning seasons (timing varies by species)	Pruning as needed	• Prune trees and shrubs in a manner appropriate for each species. Pruning should be performed by landscape professionals familiar with proper pruning techniques • All pruning of mature trees should be performed by or under the direct guidance of an ISA certified arborist
	A		Large trees and shrubs interfere with operation of the facility or access for maintenance	• Prune trees and shrubs using most current ANSI A300 standards and ISA BMPs. • Remove trees and shrubs, if necessary.
	Fall and Spring		Standing dead vegetation is present	• Remove standing dead vegetation • Replace dead vegetation within 30 days of reported dead and dying plants (as practical depending on weather/planting season) • If vegetation replacement is not feasible within 30 days, and absence of vegetation may result in erosion problems, temporary erosion control measures should be put in place immediately. • Determine cause of dead vegetation and address issue, if possible • If specific plants have a high mortality rate, assess the cause and replace with appropriate species. Consultation with a landscape architect is recommended.
	Fall and Spring		Planting beneath mature trees	• When working around and below mature trees, follow the most current ANSI A300 standards and ISA BMPs to the extent practicable (e.g., take care to minimize any damage to tree roots and avoid compaction of soil). • Planting of small shrubs or groundcovers beneath mature trees may be desirable in some cases; such plantings should use mainly plants that come as bulbs, bare root or in 4-inch pots; plants should be in no larger than 1-gallon containers.

No. 21 (continued) - Maintenance Standards and Procedures for Bioretention Facilities.

Maintenance Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Vegetation (cont'd)				
Trees and shrubs (cont'd)	Fall and Spring		Planting beneath mature trees	• When working around and below mature trees, follow the most current ANSI A300 standards and ISA BMPs to the extent practicable (e.g., take care to minimize any damage to tree roots and avoid compaction of soil). • Planting of small shrubs or groundcovers beneath mature trees may be desirable in some cases; such plantings should use mainly plants that come as bulbs, bare root or in 4-inch pots; plants should be in no larger than 1-gallon containers.
	Fall and Spring		Presence of or need for stakes and guys (tree growth, maturation, and support needs)	• Verify location of facility liners and underdrain (if any) prior to stake installation in order to prevent liner puncture or pipe damage • Monitor tree support systems: Repair and adjust as needed to provide support and prevent damage to tree. • Remove tree supports (stakes, guys, etc.) after one growing season or maximum of 1 year. • Backfill stake holes after removal.
Trees and shrubs adjacent to vehicle travel areas (or areas where visibility needs to be maintained)	A		Vegetation causes some visibility (line of sight) or driver safety issues	• Maintain appropriate height for sight clearance • When continued, regular pruning (more than one time/ growing season) is required to maintain visual sight lines for safety or clearance along a walk or drive, consider relocating the plant to a more appropriate location. • Remove or transplant if continual safety hazard • Consultation with a landscape architect is recommended for removal, transplant, or substitution of plants
Flowering plants		A	Dead or spent flowers present	Remove spent flowers (deadhead)
Perennials		Fall	Spent plants	Cut back dying or dead and fallen foliage and stems
Emergent vegetation		Spring	Vegetation compromises conveyance	• Hand rake sedges and rushes with a small rake or fingers to remove dead foliage before new growth emerges in spring or earlier only if the foliage is blocking water flow (sedges and rushes do not respond well to pruning)
Ornamental grasses (perennial)		Winter and Spring	Dead material from previous year's growing cycle or dead collapsed foliage	• Leave dry foliage for winter interest • Hand rake with a small rake or fingers to remove dead foliage back to within several inches from the soil before new growth emerges in spring or earlier if the foliage collapses and is blocking water flow
Ornamental grasses (evergreen)		Fall and Spring	Dead growth present in spring	• Hand rake with a small rake or fingers to remove dead growth before new growth emerges in spring • Clean, rake, and comb grasses when they become too tall • Cut back to ground or thin every 2-3 years as needed
Noxious weeds		M (March – October, preceding seed dispersal)	Listed noxious vegetation is present (refer to current county noxious weed list)	• By law, class A & B noxious weeds must be removed, bagged and disposed as garbage immediately • Reasonable attempts must be made to remove and dispose of class C noxious weeds • It is strongly encouraged that herbicides and pesticides not be used in order to protect water quality; use of herbicides and pesticides may be prohibited in some jurisdictions • Apply mulch after weed removal (see "Mulch")

[a] Frequency: A = Annually; B = Biannually (twice per year); M = Monthly; W = At least one visit should occur during the wet season (for debris/clog related maintenance, this inspection/maintenance visit should occur in the early fall, after deciduous trees have lost their leaves); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).

IPM – Integrated Pest Management

ISA – International Society of Arboriculture

No. 21 (continued) - Maintenance Standards and Procedures for Bioretention Facilities.

Maintenance Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Vegetation (cont'd)				
Weeds		M (March – October, preceding seed dispersal)	Weeds are present	• Remove weeds with their roots manually with pincer-type weeding tools, flame weeders, or hot water weeders as appropriate • Follow IPM protocols for weed management (see "Additional Maintenance Resources" section for more information on IPM protocols)
Excessive vegetation		Once in early to mid-May and once in early- to mid-September	Low-lying vegetation growing beyond facility edge onto sidewalks, paths, or street edge poses pedestrian safety hazard or may clog adjacent permeable pavement surfaces due to associated leaf litter, mulch, and soil	• Edge or trim groundcovers and shrubs at facility edge • Avoid mechanical blade-type edger and do not use edger or trimmer within 2 feet of tree trunks • While some clippings can be left in the facility to replenish organic material in the soil, excessive leaf litter can cause surface soil clogging
	As needed		Excessive vegetation density inhibits stormwater flow beyond design ponding or becomes a hazard for pedestrian and vehicular circulation and safety	• Determine whether pruning or other routine maintenance is adequate to maintain proper plant density and aesthetics • Determine if planting type should be replaced to avoid ongoing maintenance issues (an aggressive grower under perfect growing conditions should be transplanted to a location where it will not impact flow) • Remove plants that are weak, broken or not true to form; replace in-kind • Thin grass or plants impacting facility function without leaving visual holes or bare soil areas • Consultation with a landscape architect is recommended for removal, transplant, or substitution of plants
	As needed		Vegetation blocking curb cuts, causing excessive sediment buildup and flow bypass	• Remove vegetation and sediment buildup
Mulch				
Mulch		Following weeding	Bare spots (without mulch cover) are present or mulch depth less than 2 inches	• Supplement mulch with hand tools to a depth of 2 to 3 inches • Replenish mulch per O&M manual. Often coarse compost is used in the bottom of the facility and arborist wood chips are used on side slopes and rim (above typical water levels) • Keep all mulch away from woody stems
Watering				
Irrigation system (if any)		Based on manufacturer's instructions	Irrigation system present	• Follow manufacturer's instructions for O&M
	A		Sprinklers or drip irrigation not directed/located to properly water plants	• Redirect sprinklers or move drip irrigation to desired areas
Summer watering (first year)		Once every 1-2 weeks or as needed during prolonged dry periods	Trees, shrubs and groundcovers in first year of establishment period	• 10 to 15 gallons per tree • 3 to 5 gallons per shrub • 2 gallons water per square foot for groundcover areas • Water deeply, but infrequently, so that the top 6 to 12 inches of the root zone is moist • Use soaker hoses or spot water with a shower type wand when irrigation system is not present ○ Pulse water to enhance soil absorption, when feasible ○ Pre-moisten soil to break surface tension of dry or hydrophobic soils/mulch, followed by several more passes. With this method , each pass increases soil absorption and allows more water to infiltrate prior to runoff • Add a tree bag or slow-release watering device (e.g., bucket with a perforated bottom) for watering newly installed trees when irrigation system is not present

[a] Frequency: A = Annually; B = Biannually (twice per year); M = Monthly; W = At least one visit should occur during the wet season (for debris/clog related maintenance, this inspection/maintenance visit should occur in the early fall, after deciduous trees have lost their leaves); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).

IPM – Integrated Pest Management

ISA – International Society of Arboriculture

No. 21 (continued) - Maintenance Standards and Procedures for Bioretention Facilities.

Maintenance Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Watering (cont'd)				
Summer watering (second and third years)		Once every 2-4 weeks or as needed during prolonged dry periods	Trees, shrubs and groundcovers in second or third year of establishment period	• 10 to 15 gallons per tree • 3 to 5 gallons per shrub • 2 gallons water per square foot for groundcover areas • Water deeply, but infrequently, so that the top 6 to 12 inches of the root zone is moist • Use soaker hoses or spot water with a shower type wand when irrigation system is not present ○ Pulse water to enhance soil absorption, when feasible ○ Pre-moisten soil to break surface tension of dry or hydrophobic soils/mulch, followed by several more passes. With this method , each pass increases soil absorption and allows more water to infiltrate prior to runoff
Summer watering (after establishment)		As needed	Established vegetation (after 3 years)	• Plants are typically selected to be drought tolerant and not require regular watering after establishment; however, trees may take up to 5 years of watering to become fully established • Identify trigger mechanisms for drought-stress (e.g., leaf wilt, leaf senescence, etc.) of different species and water immediately after initial signs of stress appear • Water during drought conditions or more often if necessary to maintain plant cover
Pest Control				
Mosquitoes	B, S		Standing water remains for more than 3 days after the end of a storm	• Identify the cause of the standing water and take appropriate actions to address the problem (see "Ponded water") • To facilitate maintenance, manually remove standing water and direct to the storm drainage system (if runoff is from non pollution-generating surfaces) or sanitary sewer system (if runoff is from pollution-generating surfaces) after getting approval from sanitary sewer authority. • Use of pesticides or *Bacillus thuringiensis israelensis* (Bti)may be considered only as a temporary measure while addressing the standing water cause. If overflow to a surface water will occur within 2 weeks after pesticide use, apply for coverage under the Aquatic Mosquito Control NPDES General Permit.
Nuisance animals	As needed		Nuisance animals causing erosion, damaging plants, or depositing large volumes of feces	• Reduce site conditions that attract nuisance species where possible (e.g., plant shrubs and tall grasses to reduce open areas for geese, etc.) • Place predator decoys • Follow IPM protocols for specific nuisance animal issues (see "Additional Maintenance Resources" section for more information on IPM protocols) • Remove pet waste regularly • For public and right-of-way sites consider adding garbage cans with dog bags for picking up pet waste.
Insect pests	Every site visit associated with vegetation management		Signs of pests, such as wilting leaves, chewed leaves and bark, spotting or other indicators	• Reduce hiding places for pests by removing diseased and dead plants • For infestations, follow IPM protocols (see "Additional Maintenance Resources" section for more information on IPM protocols)

[a] Frequency: A = Annually; B = Biannually (twice per year); M = Monthly; W = At least one visit should occur during the wet season (for debris/clog related maintenance, this inspection/maintenance visit should occur in the early fall, after deciduous trees have lost their leaves); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).

IPM – Integrated Pest Management

ISA – International Society of Arboriculture